# X-RAY GENERATION

LIST OF DOCUMENTATION IN THIS BINDER:

- ⊗ SUBSYSTEM MANUAL OPTIMUS
- ⊗ UNIT MANUAL Converter R/F
- ⊗ UNIT MANUAL Cockpit for duo DIAGNOST
- ○ UNIT MANUAL Power Distribution Unit (PDU)

Note: ⊗ indicates document present

LIST OF ALL BINDERS FOR X-RAY GENERATION:

- SUBSYSTEM MANUAL OPTIMUS C (this binder)


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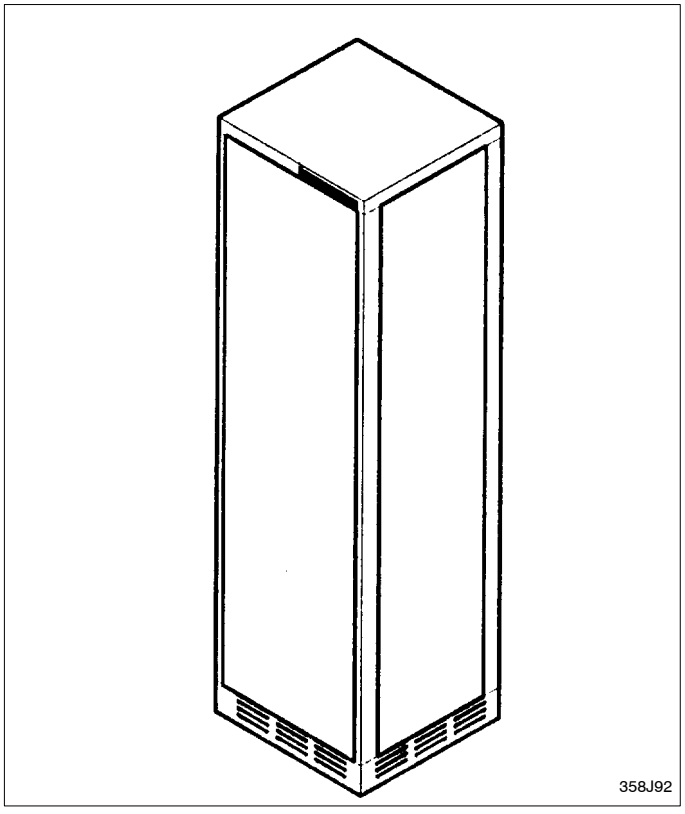
Philips Medical Systems
Development and Manufacturing Centre

PHILIPS

SERVICE MANUAL
742
SUBSYSTEM

# OPTIMUS C

**9890 000 02191**




CAN-controlled X-ray generator of the converter type

DMC Hamburg

Printed in Hamburg, Germany

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# SERVICE MANUAL - SUBSYSTEM

## OPTIMUS C

Author: P. Thron

Type No: 9890 000 02191
Techn. No: Basis 4512 104 70625

Release: 1.2

In case there are any questions concerning this manual,
please send this LOPAD via fax to 49/(0)40/5078 2481

File: OPTIMUS_C_08497_AB

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**List of pages and drawings** (LOPAD)

**Manual Order No: 4512 984 08497**
**released: 04/2003**

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**(nur für Fabrik-Auslieferung)**

Service software No:

- OMC : 4512 116 0240x



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# INTRODUCTION AND TECHNICAL DATA

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# 1. Product information

The Optimus family of generators for radiography is based on computer-controlled converter technology.
The converter operates in the non-audible frequency range.

Applicable options can be enabled by releasing software modules using customized PAL ICs depending on the respective order.
Control between the internal **F**unction **U**nits (FUs) and the external online equipment takes place by a CAN bus.

Safety-relevant signals are transferred directly on the so-called “Signal bus”.

## 1.1. Applications

- Radiography
- Tomography
- Fluoroscopy

## 1.2. Options

### 1.2.1. Hardware options

- Mains transformer PDU: 400 – 480V; 50 / 60Hz,
  also for 400V mains supply without neutral lead N
  with taps for 400 / 440 / 460 / 480V . . . . . 9890 000 0260x
- Mains transformer: 190–390V; 50 / 60Hz
  with taps for 190 / 200 / 207 / 220 / 230 / 240 / 250 / 343 / 380 / 390V
  **max. 50kW!** . . . . . 9803 720 8100x

### 1.2.2. Software options

Software options are provided via the function key (see also 5Z–1, EZ 139 Central Unit D38).
Additional hardware components are not required.

All system options are available.
All Optimus C have the same function key configuration, there is only a difference in the power class 50/65/80kW.

# 2. Compatibility

## 2.1. Generator components

- Base OPTIMUS C . . . . . 9890 000 0219x
- H.V. transformer R/F . . 1 tube, 50kW . . . . . 9890 000 0270x
- H.V. transformer R/F . . 1 tube, 65/80kW . . . . . 9890 000 0272x
- 50kW extension – R/F . . . . . 9890 000 0274x
- 65kW extension – R/F . . . . . 9890 000 0275x
- 80kW extension – R/F . . . . . 9890 000 0276x
- Firmware Rel. 1.2 . . . . . 9890 000 0254x


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## 2.2. Tubes

**Recommended standard tubes:**

- RO 17 50
- SRM 06 12
- SRO 25 50
- SRO 33 100

**Further compatible tubes:**

- RO 12 30
- RO 16 48
- RO 30 50 RE
- SRO 09 51
- SRO 13 30
- SRO 20 50
- SRO 20 55
- SRO 22 50
- SRO 32 100

**Compatible tube housings:**

- ROT 350
- ROT 351
- ROT 504

The latest information on further tubes which are connectable is available at the service center Hamburg.

## 2.3. System components

- DuoDiagnost GEOMETRY . . . . . 9890 000 0290x
- Stand for operating panel . . . . . 9890 000 0244x
- Wall mounting of operating panel . . . . . 9890 000 0245x
- User interface support . . . . . 9890 000 0283x
- Cable set for COCKPIT . . . . . 9890 000 0279x

# 3. Mechanical data

For installation dimensions and weights see drawings Z-1.1.

**Transport data:**

| Case no. | Contents | Weights [kg] | | Dimensions [cm] | | |
|---|---|---|---|---|---|---|
| | | net | gross | length | width | height |
| 1 | - Generator cabinet<br>- Operating panel<br>- Cables | 178 | 226 | 210 | 82 | 84 |
| 2 | - H.V. generator; 1-tube version | 73 | 100 | 77 | 67 | 80 |


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# 4. Environmental data

The environmental data comply with to PMS standard UXW 13600.

## 4.1. Electrical environment

Class S0 – Dedicated mains supply, 3 phases and neutral. Thus single phase voltage is also available.

A low impedance, permanently installed connection, fed in by the step down transformer of the hospital to supply large systems like in MR, CT and X–ray departments is required.

**Note**
*Use always a mains cable with 4 wires and concentric PE–shield, type NYCY.*

## 4.2. Climatic conditions

Ambient temperature . . . . . 10°C – 40°C
Relative humidity . . . . . 15% – 90%; no condensation
Relative atmospheric pressure . . . . . 70kPa – 110kPa

## 4.3. Emission

Heat dissipation . . . . . max. 1200W; average per hour
Noise level, normal operation . . . . . ≈ 46dBA
Noise level, maximum power operation . . . . ≈ 55dBA
EMC . . . . . IEC 950

To avoid any possible annoying noise of the implemented fans it is advisable to install the generator cabinet outside the examination room.


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# 5. Electrical data

## 5.1. Power data and mains conditions

| | Voltage | | |
|---|---|---|---|
| | **50kW** | **65kW** | **80kW** |
| Mains voltage | 3 x 400V ±10% (415V $^{+6\%}$ / 380V $_{-5\%}$) | | |
| | 3 x 400 / 440 / 460V ±10% * <br> 3 x 480V $^{+6\%}$ \| $_{-10\%}$ * <br> * = with external transformer PDU (option) <br> The following connection cables are recommended: <br> Input: 3 +1 x 10mm$^2$ (L1, L2, L3, PE) <br> Output: 4 x 4mm$^2$ Generator supply 3 x 400V <br> 4 + 1 x 4mm$^2$ Device supply 3 x 220V (option) <br> 3 x 1,5mm$^2$ Switch control and temperature supervision | | |
| | 3 x 190 ... 343V ±10% ** <br> ** = with external transformer; max. 50kW (option) | | |

| | Frequency | | |
|---|---|---|---|
| | **50kW** | **65kW** | **80kW** |
| Mains frequency | 49 ... 61Hz | | |


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| Voltage | | Max. mains current 50kW | 65kW | 80kW |
|---|---|---|---|---|
| **Exposure:** | 400V | 145A | 190A | 230A |
| | 440V | 135A | 180A | 215A |
| | 460V | 125A | 170A | 210A |
| | 480V | 120A | 160A | 205A |
| | 190V | 300A | – | – |
| **Short-time power consumption [I x U x √3]** | | 100kVA | 132kVA | 160kVA |
| **Fluoro:** | 400V | – | 8A | |
| | 480V | – | 7A | |
| **Fuse protection (slow blow)** | | 35A | 50A | |
| | | 100A at ≤ 240V | | |
| **Connected load [$I_{Fuse}$ x U x √3]** | | 25kVA | 35kVA | |
| **Emergency power supply:** | static (Inverter) | Short-time power consumption [I x U x √3] | | |
| | dynamic (Diesel generator with flywheel mass) | Connected load [$I_{Fuse}$ x U x √3] | | |

| Voltage | Mains resistance 50kW | 65kW | 80kW |
|---|---|---|---|
| 400V | ≤ 300mΩ | ≤ 200mΩ | |
| 440V | ≤ 350mΩ | ≤ 240mΩ | |
| 460V | ≤ 350mΩ | ≤ 240mΩ | |
| 480V | ≤ 400mΩ | ≤ 300mΩ | |
| 480V valid for DOD only | ≤ 300mΩ | ≤ 240mΩ | ≤ 180mΩ |
| | **Note** *500mΩ is the **absolute max.** mains resistance.* | | |



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## 5.2. Power supply for application

| Supply | Generator power | | |
|---|---|---|---|
| | **50kW** | **65kW** | **80kW** |
| Output 1 | 230V / 400V; generator switched and protected | | --> $I_1$ |
| Output 2 | 230V / 400V; generator switched and protected | | --> $I_2$ |
| Output 3 | 230V / 400V; generator **not switched** and protected | | --> $I_3$ |
| | Sum value $I_{max\ (1\ +2\ +3)} \leq 10A$ | | |
| Only with external transformer PDU | | | |
| Output 4 | 127V / 220V generator switched and protected | | --> $I_4$ |
| Output 5 | double socket 127V / 15A to phase L1; generator **not switched** and protected | | --> $I_5$ |
| | Sum value $I_{max\ (4\ +5)} \leq 16A$ | | |

## 5.3. Operating data

| Data | | Generator power | | |
|---|---|---|---|---|
| | | **50kW** | **65kW** | **80kW** |
| **Exposure:** | Tube current | 1 ... 650mA | 1 ... 900mA | 1 ... 1100mA |
| | Tube voltage | 40 ... 150kV in kV- or %-steps | | |
| | mAs product | 0,5 ... 850mAs | | |
| | Exposure time | 1ms ... 6s / 16s | | |
| | Exposure frequency | ≤ 12exp./s | | |
| | Interfacing option for | door contact, external radiation warning indicator | | |
| **Fluoro:** | Tube current | 0,25 ... 6mA | | |
| | Tube voltage | 40 ... 110kV | | |
| | kV/mA curves | 3 | | |
| | Setting time | ≤ 1s | | |


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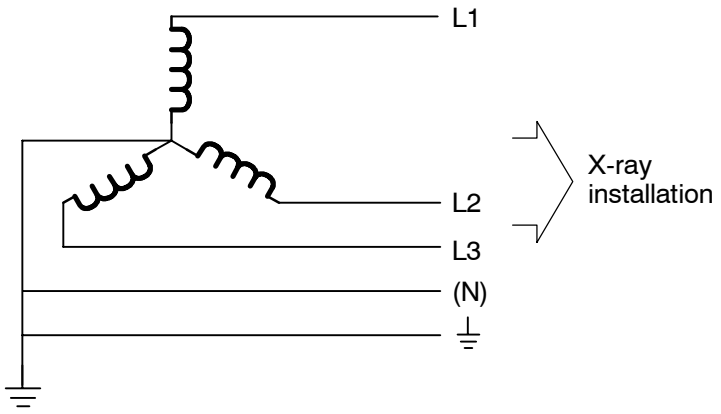
## 5.4. Power supply

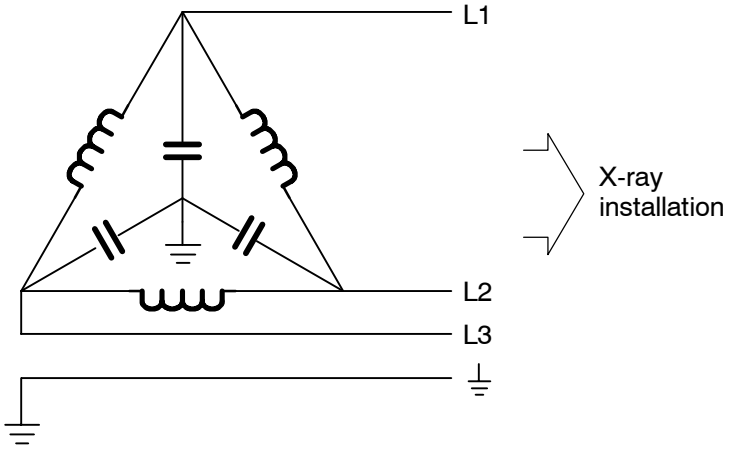
### 5.4.1. Type of power supply

**3 phase WYE**



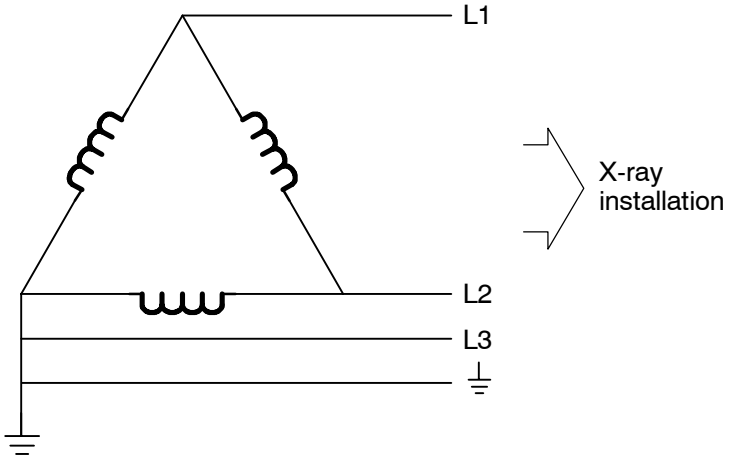

- 400V
- 440V / 460V / 480V with external mains transformer PDU 9890 000 0260x.
- Neutral not required if the external mains transformer PDU 9890 000 0260x is ordered.
- 190V ... 343V with external mains transformer 9803 720 8100x (max. 50kW).

**3 phase DELTA, balanced earth or floating**




- External mains transformer PDU 9890 000 0260x is required.
- 400V / 440V / 460V / 480V
- 190V ... 343V with external mains transformer 9803 720 8100x (max. 50kW).

**3 phase DELTA, grounded**




- External mains transformer PDU 9890 000 0260x is required (requires modification at the EMC-filter of the kV power unit).
- 400V / 440V / 460V / 480V

**Caution!**
**Ensure the sequence of phases in the wall junction box corresponds to designations L1, L2, L3.**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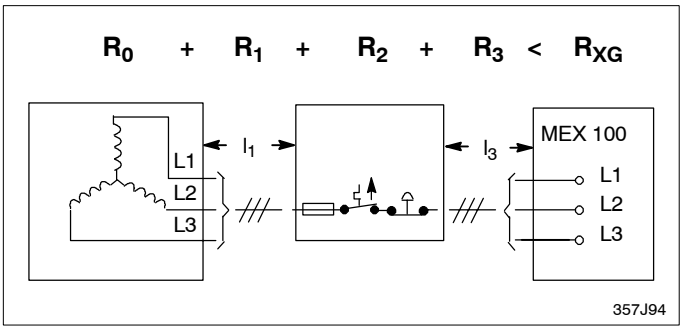
### 5.4.2. Calculating the mains resistances

**Note**
*The cross section of lead $l_3$ must not exceed 25mm$^2$. (See figure below).*

If possible the sum of $R_0$, $R_1$, $R_2$ and $R_3$ should be smaller than the $R_{XG}$ requires.
With higher internal mains resistances the generator output is reduced correspondingly.




**$R_0$** designates the mains resistance of the distributor transformer

**$R_1$** depends on the length of lead $l_1$ between distributor transformer and mains distributor and on the selected cross section as well:

==> $R_1 = l_1 \times R_{Cu}$ $R_{Cu}$ from table below

**$R_2$** consists of upstream elements such as:

- Emergency-OFF switch . . . . . 4.0mΩ
- Earth-leakage circuit breaker . . . . . 5.5mΩ
- Fuse . . . . . 5.5mΩ
- Surge arrester WN . . . . . 23.0mΩ

**$R_3$** depends on the length of lead $l_3$ between mains distributor and wall junction box and on the selected cross section as well:

==> $R_3 = l_3 \times R_{Cu}$ $R_{Cu}$ from table below

The resistances consider the go and return lines so that the calculation can be based on simple cable lengths.

| Copper cross section [mm$^2$] | Resistance $R_{Cu}$ [mΩ/m] |
|---|---|
| 16 | 2.19 |
| 25 | 1.4 |
| 35 | 1.0 |
| 50 | 0.7 |
| 70 | 0.5 |
| 95 | 0.38 |
| 120 | 0.30 |
| 150 | 0.24 |

**Note**
*500mΩ is the **absolute max.** mains resistance.*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#### 5.4.3. Earth-leakage circuit breaker

To be provided between mains fuse and X-ray installation depending on local regulations.

Siemens earth-leakage circuit breaker:

- Order No.: 5SZ3 466 OKG00
- Rated fault current 30mA
- Rated current 63A
- Connection terminals for wire cross sections of up to 25mm$^2$

#### 5.4.4. Emergency-OFF device

To be provided depending on local regulations.

There are 2 possibilities:

1. All the emergency-OFF buttons are connected in series and looped into the switch-ON circuit (12VDC) of the generator.
2. The emergency-OFF circuit acts on an external mains contactor which switches OFF the power before it is fed into the generator.

## 6. Tools

- Service engineer standard tool kit
- Service-PC:
  IBM-compatible, 640kB RAM, 3.5" floppy disk drive, ≥ 1 serial port
- Installation and service software OMC: 4512 116 024xx.
  Supplied on a floppy disk within this generator service manual.
- PC-hardkey (DIAGGEN):
  Necessary to carry out the installation and to run the service software (special programmings, fault finding).
- 0-modem cable:
  Minimum length is distance between generator cabinet and operating desk.
  Male 25-pole D-Sub connector at the generator side.
  A 5m data cable of bucky controller can be used: 4512 130 5693x
- Mains resistance measuring instrument
- Dose measuring instrument
- mAs-meter
- Multimeter
- Digital oscilloscope with 2-beam memory
- Recommended PLCC extraction tool (AMP 822154-1): 2422 487 89772

## 7. Traceable items

The following items have serial numbers of the following format when delivered ex factory:

1. Generator cabinet . . . . . 6 digit serial number

2. H.V. tank . . . . . 7 digit serial number


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# 8. Preparation

Connection of the generator: . . . . . see drawing Z-6.1
Connection of the generator with PDU: . . . . . see drawing Z-6.2
Operating panel: . . . . . see drawing Z-1.3
Connection diagram: . . . . . see drawing Z-7.1/.2
Earthing diagram: . . . . . see drawing Z-7.3
Legend for earthing and cabeling: . . . . . see drawing Z-7.10

## 8.1. Installation material

To be ordered from the service department of PMS Hamburg:

- Wall junction box . . . . . 4512 103 7538x
  inclusive connection block (25mm$^2$) for mains supply and connection block (10mm$^2$) for unit supply.
- Relay for radiation warning indicator . . . . . 4512 100 4523x
  1 interface relay with a floating contact (230V/1A) is included in the scope of delivery of the generator.

## 8.2. Cables

**H.V. cables**

with O3 / O3 plugs: . . . . . 9806 402 6xx02
length: . . . . . 6m – 30m in steps of 2m
capacity: . . . . . 155pF/m
diameter: . . . . . 16.5mm
The cable length is indicated by the 9th and 10th digit of the numeric code.

**Thermal contact cable**

- 2-wire screened for 1 excess temperature switch . . . . . 4512 100 66151
- 10-wire screened for additional supervision like
  temperature alarm switch, buzzer, selection indicator . . . . . 0722 215 19005

**Stator cable**

- Tube SRM-0612 : 3x 1,31 mm$^2$, screened with uMNL-connector . . . . 3322 405 14191
- all other tubes :
  3 × 1.31mm$^2$, screened . . . . . 0722 215 02054

**AMPLIMAT cable**

with D-Sub and 3-Plus plug:

12m . . . . . 9890 000 01721
16m . . . . . 9890 000 01731
20m . . . . . 9890 000 01741
24m . . . . . 9890 000 01751

**Note**
*The above described cables are part of the pre-assembled systems.*


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### 8.3. Manpower

At least two persons are necessary to insert the H.V. tank in the generator cabinet.
The weight is about 73kg.

## 9. Planned maintenance

The technical documentation for carrying out maintenance work in compliance with the applicable regulations are available at the responsible authority of Philips Medical Systems.

The importance of having maintenance implemented is pointed out to the operator in the operating instructions.

It must be guaranteed that the person carrying out maintenance work knows about the respective national regulations and that this person observes these regulations throughout all steps of maintenance work.


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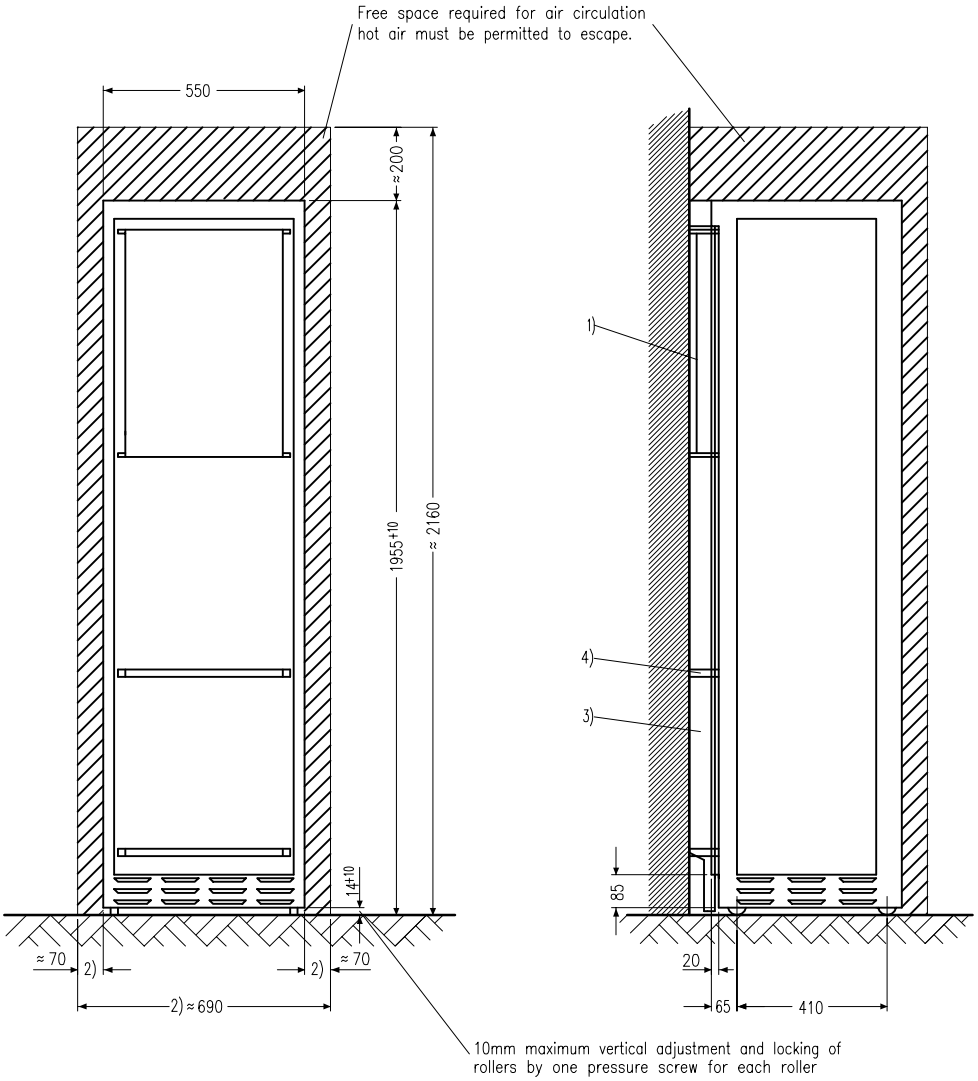
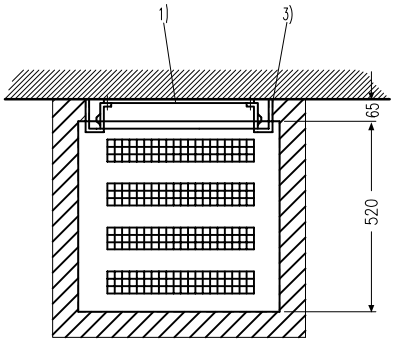


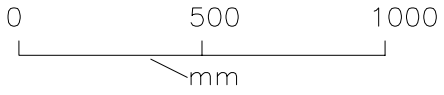

1) Wall junction box

2)Lateral clearance unless there is an adjacent cabinet

3) Filler panel

4) Wall–cabinet spacing angle

weight : 210 kg




# Generator Cabinet
# Mechanical dimensions

A4 01–11–22 Schr/Ost.
4512982009 21_z1_1_010



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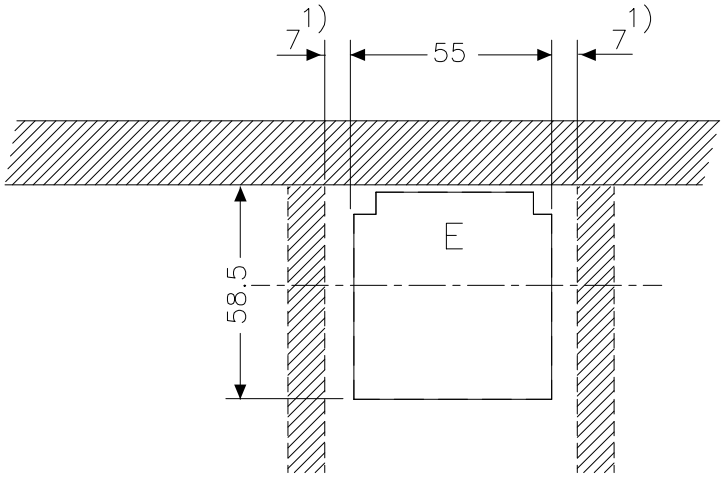
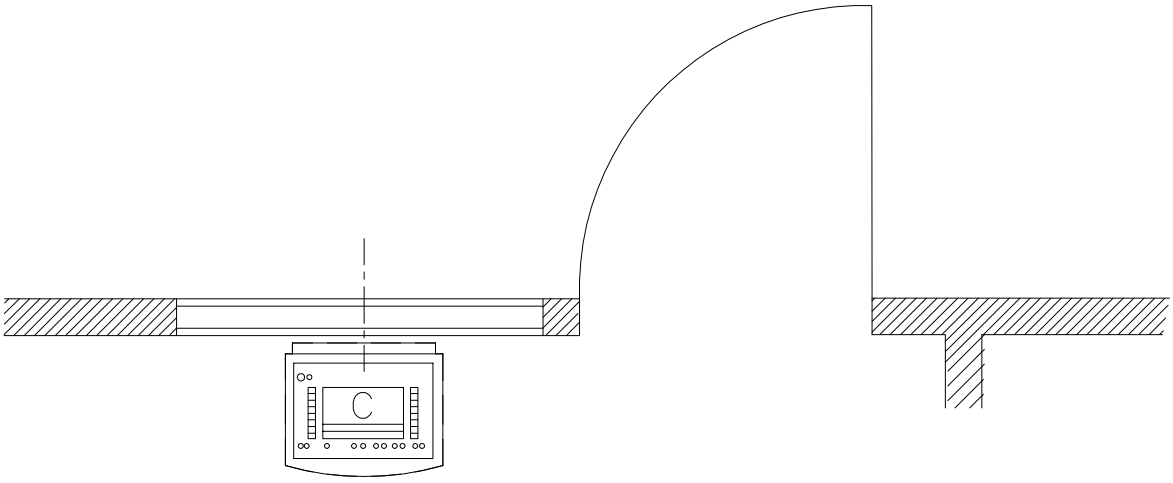
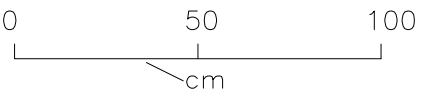



1) With no other cabinets beside them

E= Control cabinet

C= Operating desk




Product Planning Data

A4 02-04-17 Schr./dp

4512982009 91_z1_2_020

OPTIMUS C

Overlayer for room layout



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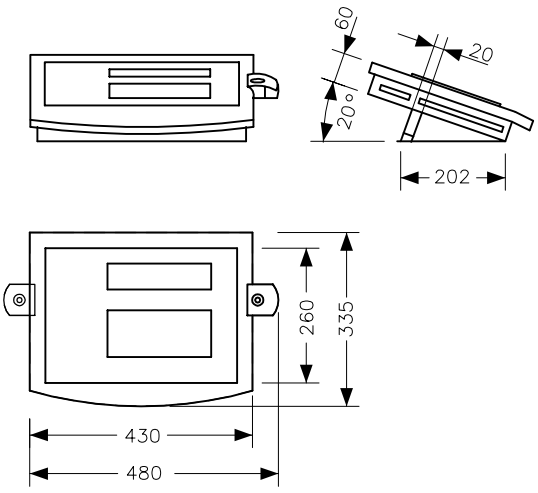
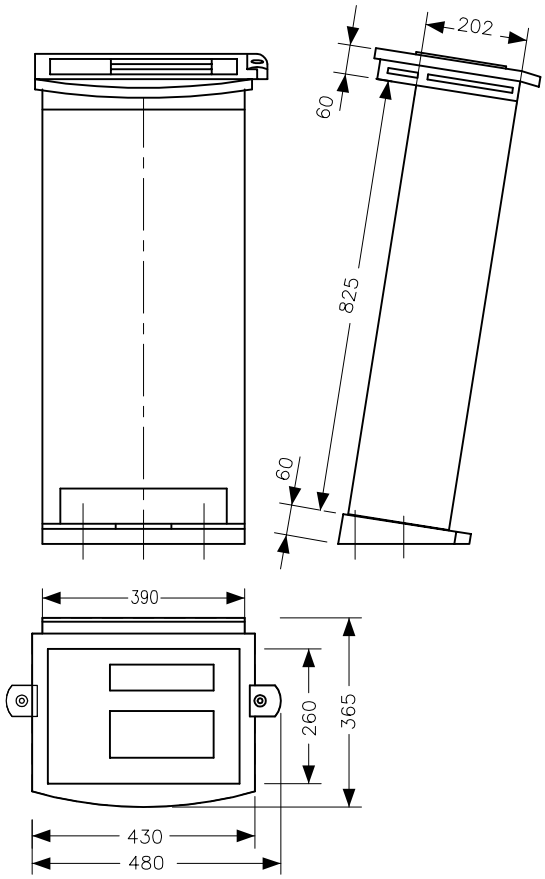
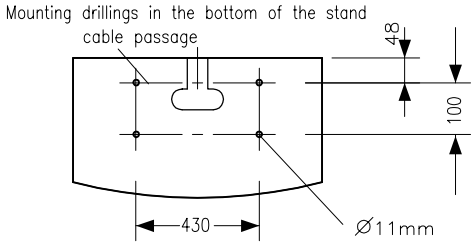
## ① Low profile control desk



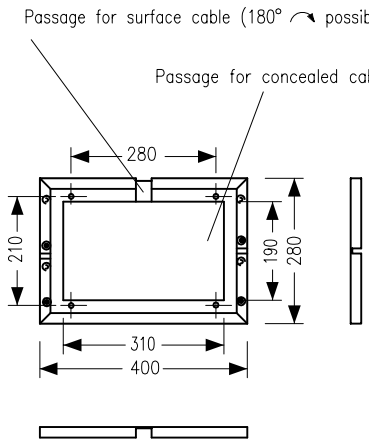

## ② Stand for low profile control desks

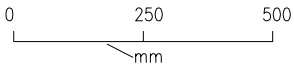



**Note:**
In this drawing the control desk is shown.
The dimensions are also valied for cockpit CB.



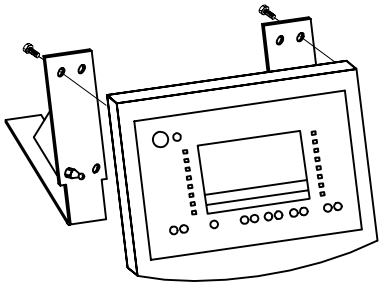

## ③ Wall-mounting support




## ④ User interface support

(not possible for digital DIAGNOST)



Product Planning Data

A3 01-11-22 Ost.
4512982009 91_z1_3_010

# Operating panel
# Mechanical dimensions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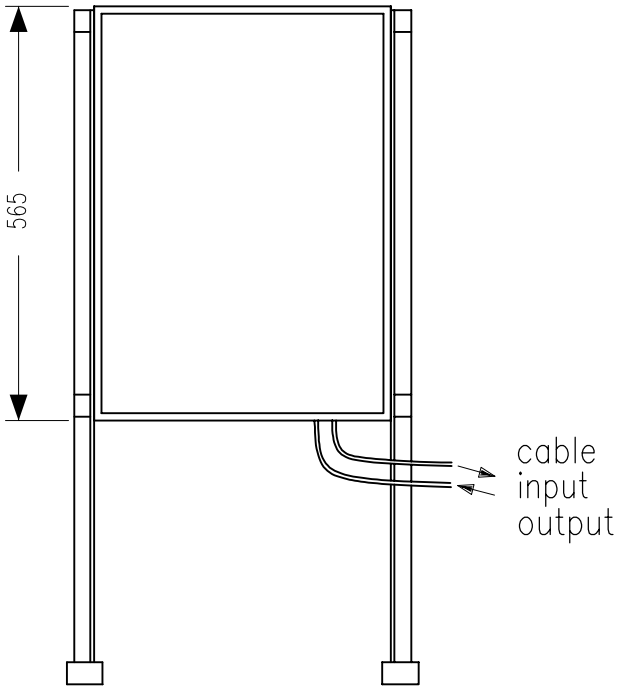
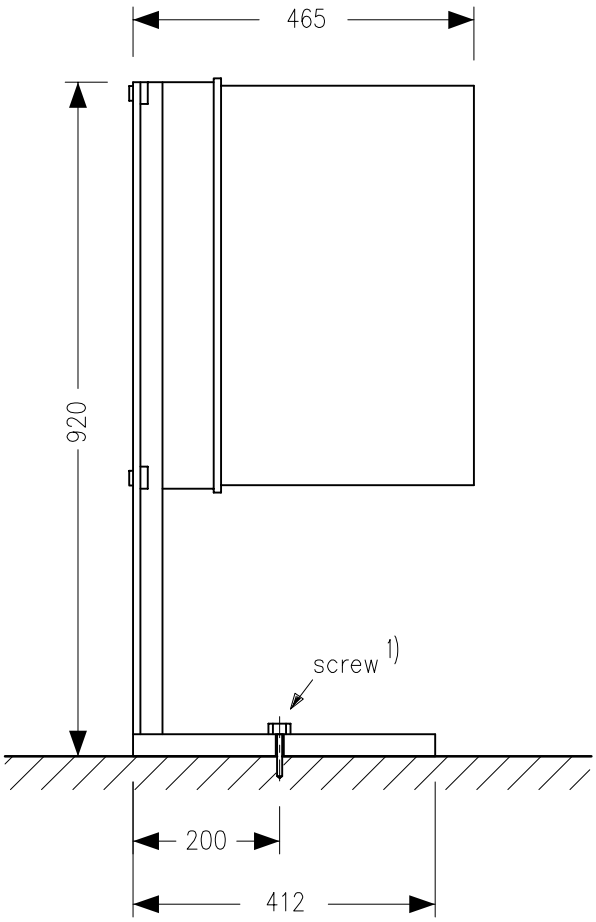
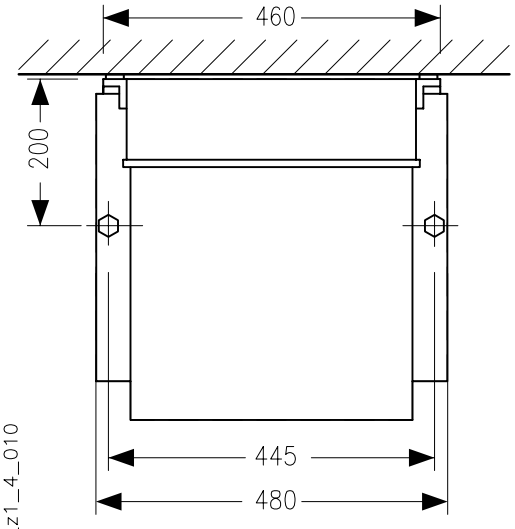
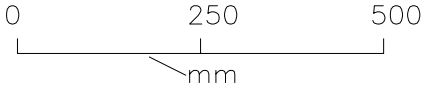



1) Screw connection (screws 7 x 60, dowels 8) only when requested. It is actually not needed




Weight 100 kg




Product Planning Data

A4 01-11-23 Ost.
4512982009 91_z1_4_010

# Power distribution unit (PDU) 9890 000 0260x Dimensions and weight



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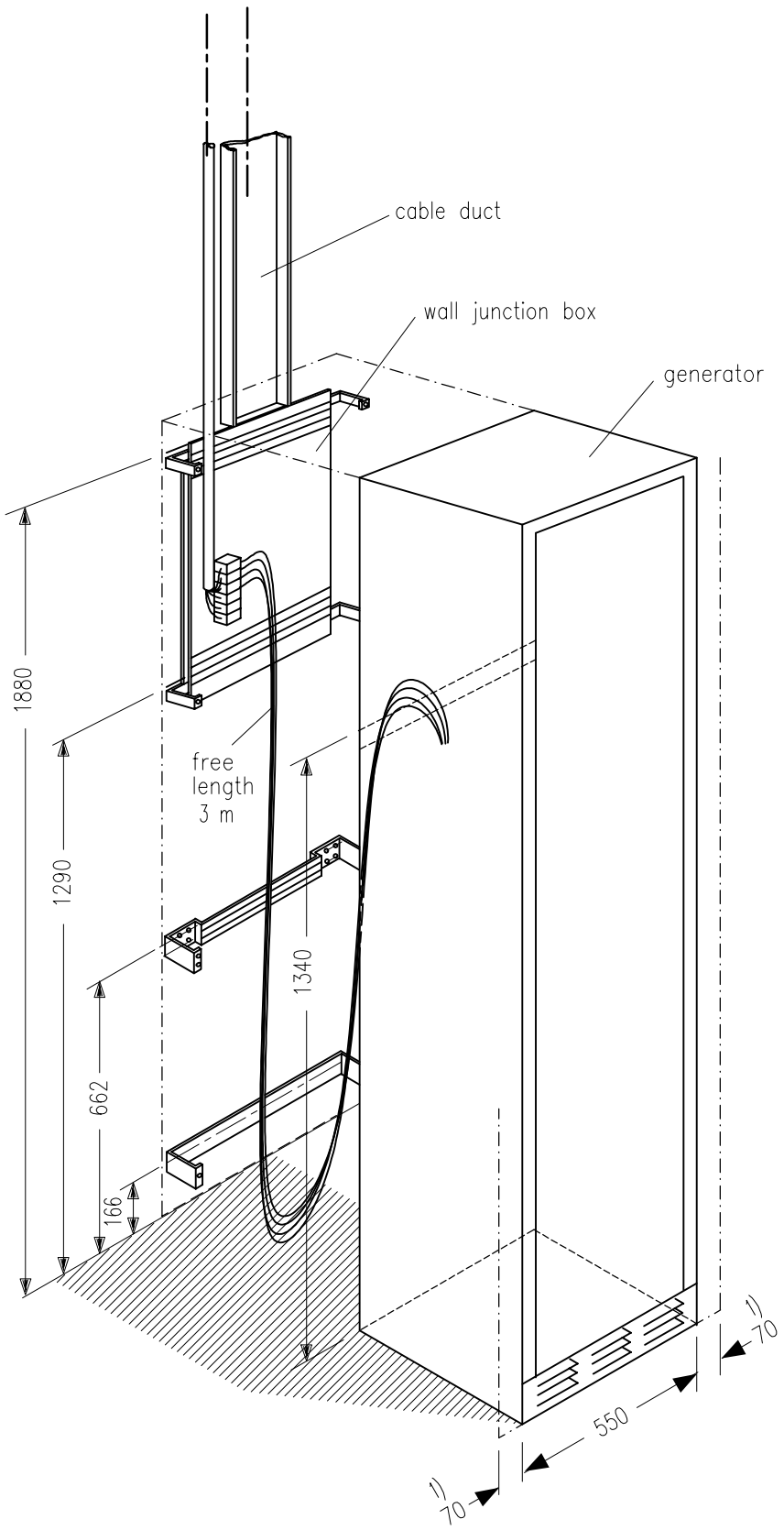


1) Space with no other cabinets beside them.

# Connection of generator



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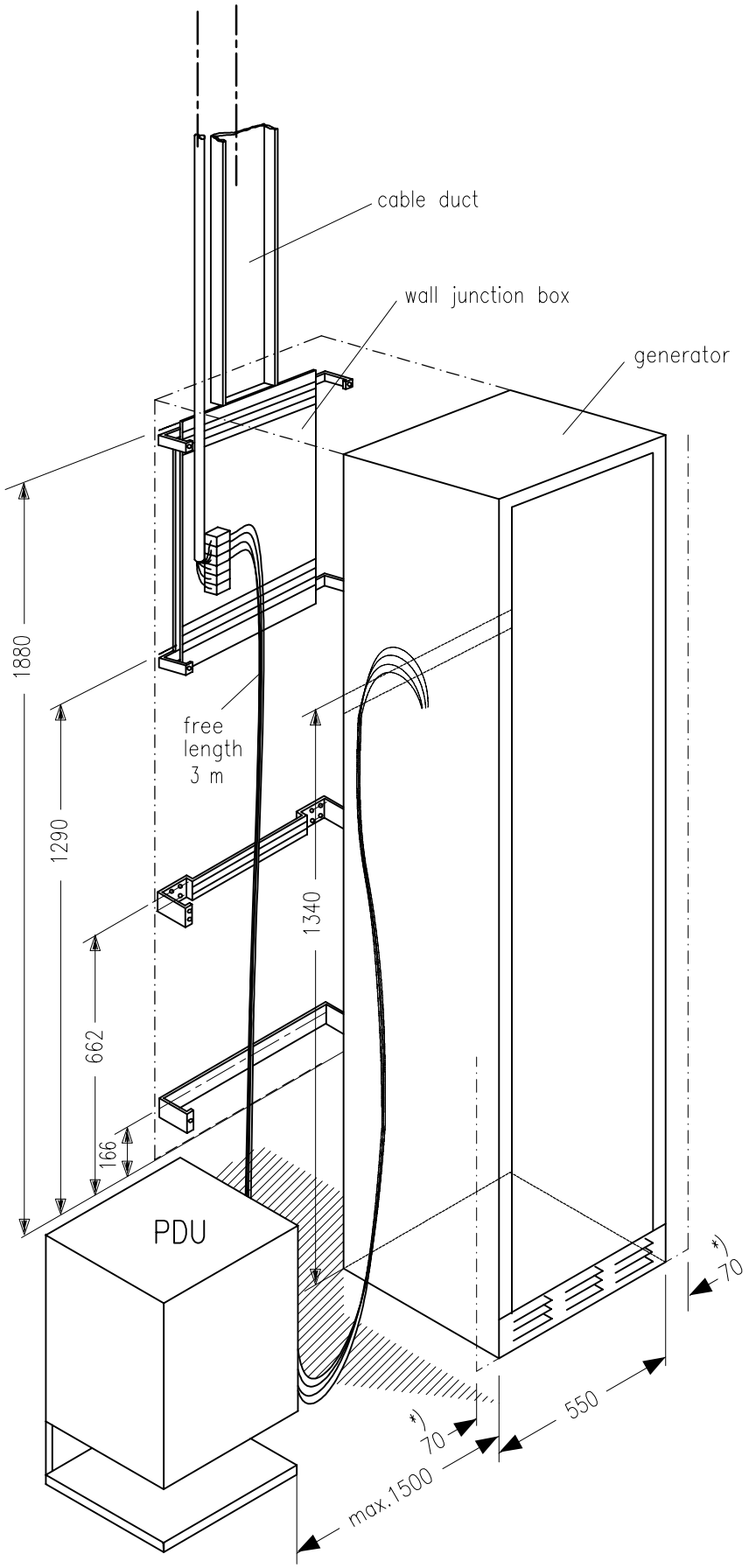


*) Space with no other cabinets beside them.

# Connection of generator with Power Distribution Unit (PDU)



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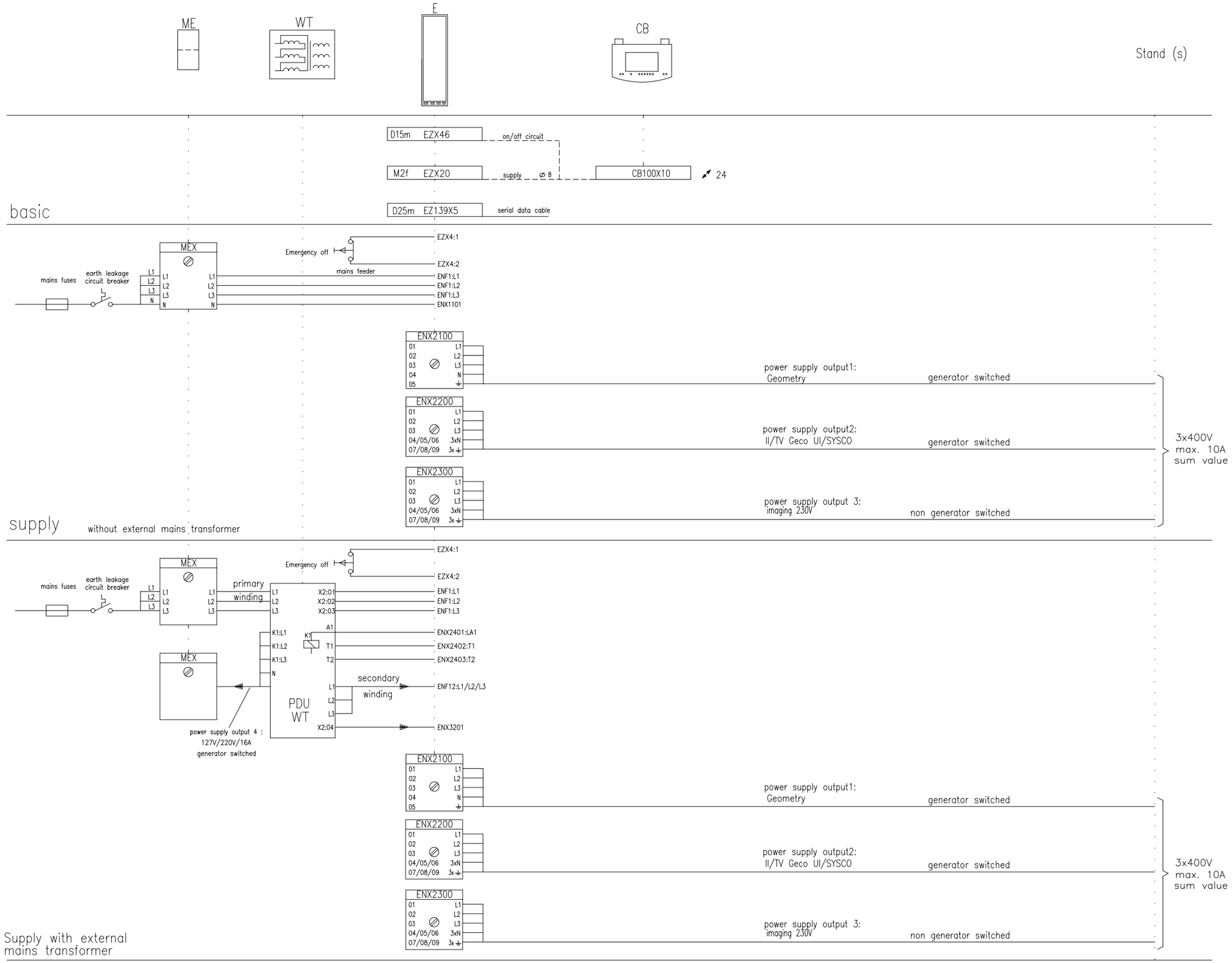


A3 02-04-17 Schr,/dp
4512982009 91_z7_1_020

OPTIMUS C
Connection diagram



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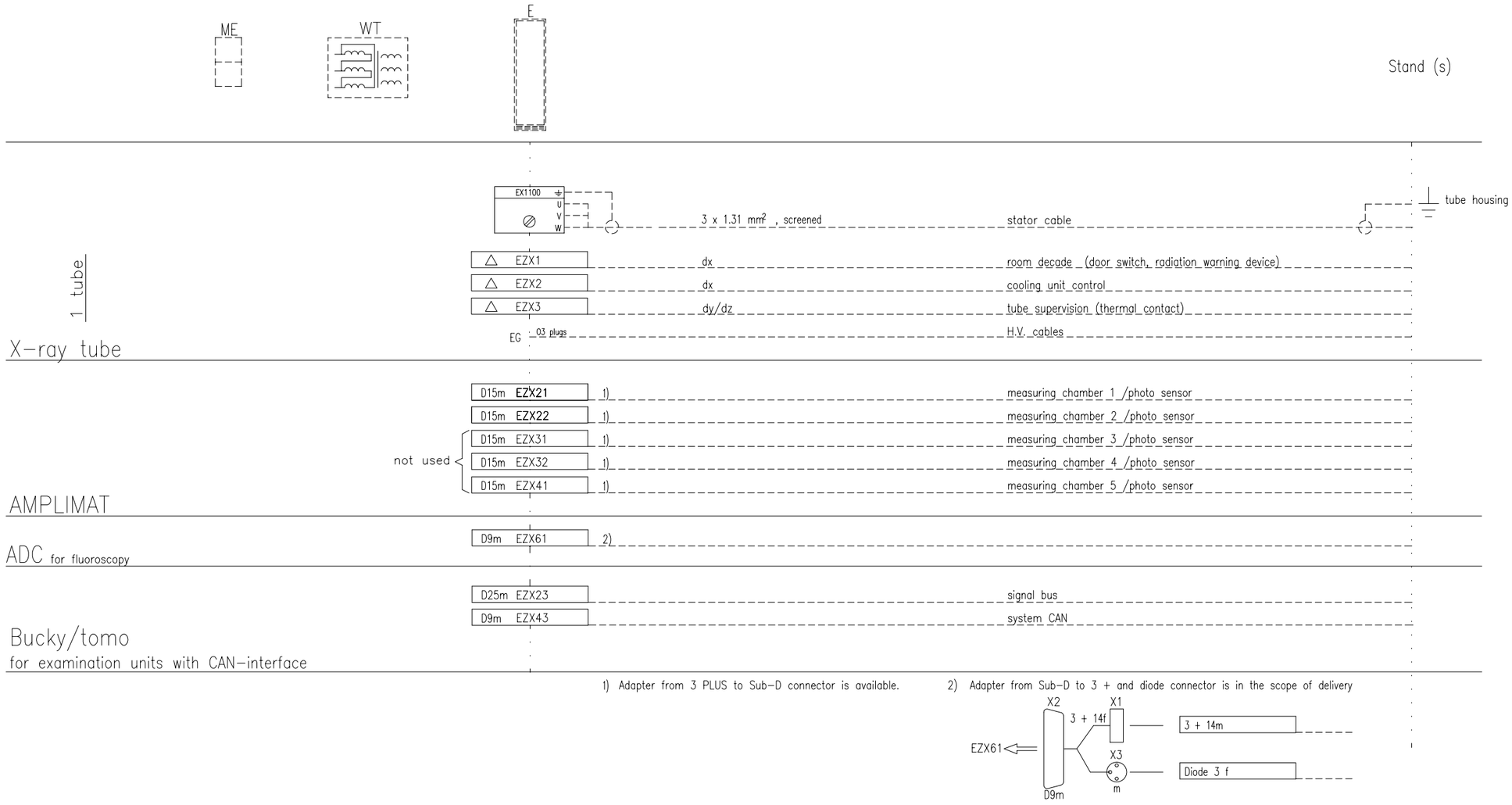


Product Planning Data

A3 02-04-17 Schr./dp
451298200991_z7_2_020

OPTIMUS C
Connection diagram

Z-7.2


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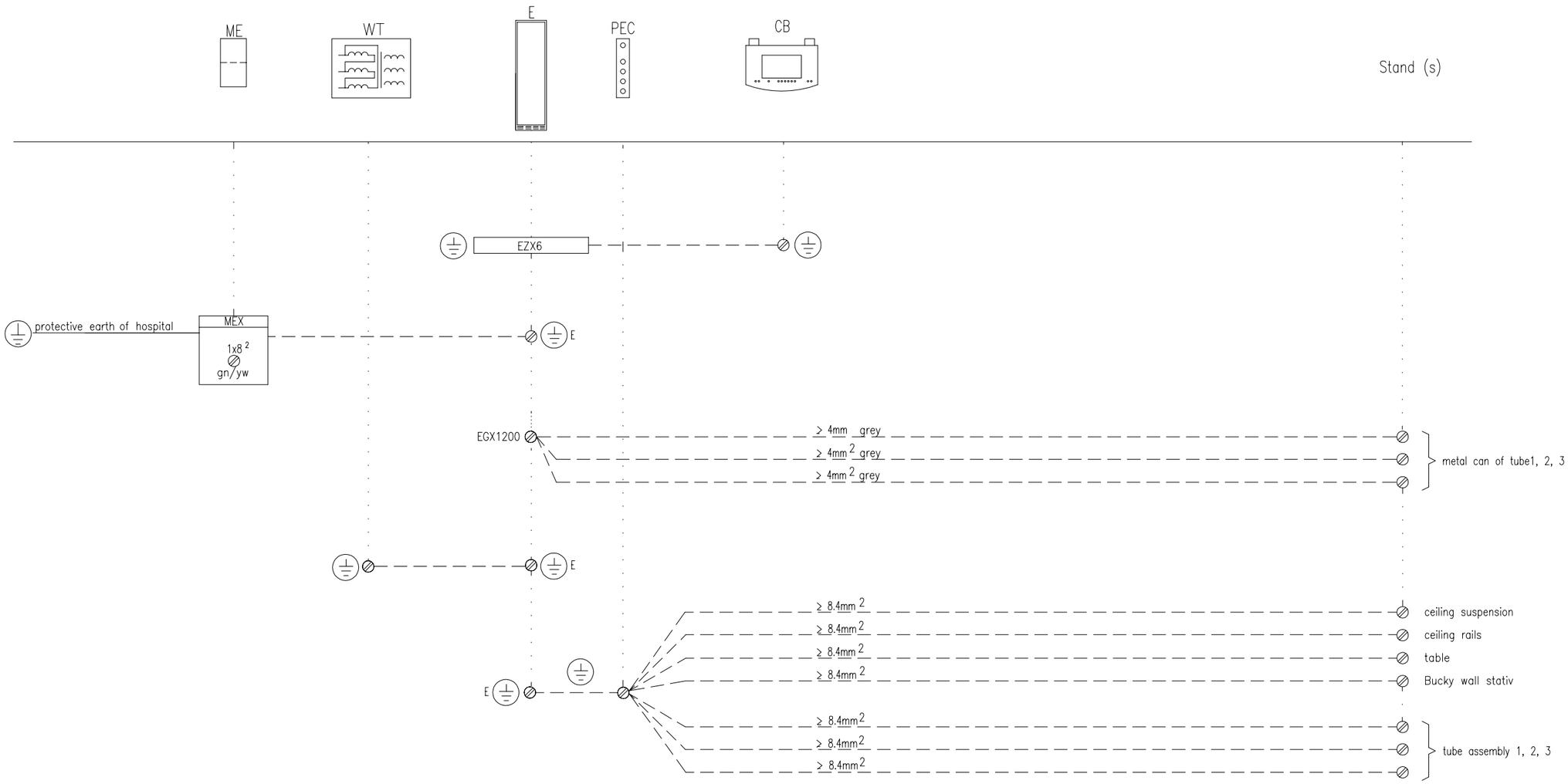


A3 02-04-17 Schr/dp
4512982009 91_z7_3_020

OPTIMUS C
Earthing diagram

Z-7.3

4512 982 0099. (02.0)
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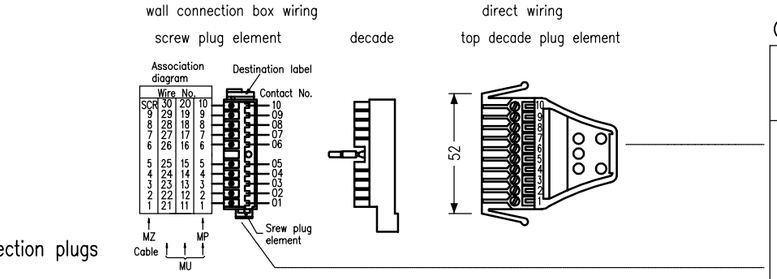
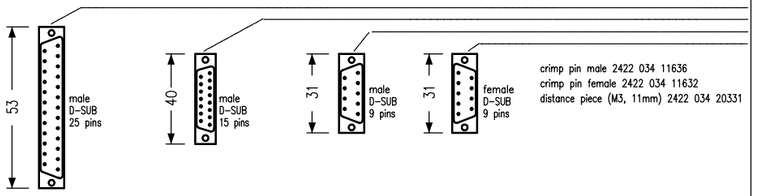
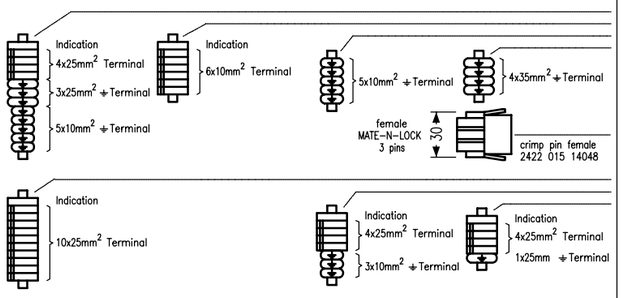
System Planning Data

## – Connection plugs




## – Connector rails




## – Cables

| Description | | Data | | Codenumber | quantity |
|---|---|---|---|---|---|
| M (4 x 0.75 mm²) | | ø8.0 | | 0712 164 01002 | xx metre |
| N (7 x 1.5 mm²) | | ø13.5 | | 0712 163 03001 | xx metre |
| Q (18 x 1 mm²) | | ø19.0 | | 0712 163 00001 | xx metre |
| R (25 x 1 mm²) | | ø21.2 | | 0712 164 10003 | xx metre |
| MU (34 x 1 mm²) | | ø21.1 | | 4512 152 31061 | xx metre |
| MP (12 x 1.5 mm²) | | ø14.1 | | 4522 100 85001 | xx metre |
| MT ((4 + 1) x 10 mm²) | | ø20.5 | | 4512 152 31201 | xx metre |
| MT ((4 + 1) x 16 mm²) | | ø24.5 | | 4512 152 31161 | xx metre |
| MT ((4 + 1) x 25 mm²) | | ø31.0 | | 4512 152 31181 | xx metre |
| MM (5 x 2.5 mm²) | | ø14.3 | | 0722 207 04022 | xx metre |
| MY ((6 + 1) x 0.5 mm² screened) | | ø9.3 | | 0722 212 02003 | xx metre |
| MZ (9 x 0.82 mm² screened) | | ø15.6 | | 0722 215 16002 | xx metre |
| MW (2 x 0.82 mm²) | | ø6.7 | | 0722 300 01004 | xx metre |
| da (3+1 x 1.38 mm²) | | ø8.0 | | 0722 207 03044 | xx metre |
| db (3 x 1.3 mm² screened + yield) | (AWG 16) | ø9.2 | | 0722 215 02054 | xx metre |
| dc (2 x 0.8 mm²) | | ø6.2 | | 0722 300 01011 | xx metre |
| dd (5 x 2 x 0.22 mm² screened) | | ø7.4 | (twisted pair) | 0722 215 62001 | xx metre |
| de (12 x 2 x 0.22 mm² screened) | | ø9.6 | (twisted pair) | 0722 215 51007 | xx metre |
| df (10 x 0.5 mm²) | | ø7.3 | | 4512 100 66451 | xx metre |
| dg (10 x 0.5 mm² screened) | | ø7.8 | | 0722 997 07248 | xx metre |
| dh (8 x 2 x 0.22 mm² screened + yield) | | ø8.4 | (twisted pair) | 0722 215 33008 | xx metre |
| dx (10 x 0.5 mm² mushroom) | | ø9.0 | | 0722 276 05003 | xx metre |
| dy (2 x 0.5 mm² mushroom , screened) | | ø5.3 | | 4512 100 66151 | xx metre |
| dz (10 x 0.5 mm² mushroom , screened) | | ø10 | | 0722 215 19009 | xx metre |
| (5 + 2) x 0.85 mm² stator cable | | ø11.5 | | 0722 464 02003 | xx metre |
| 4 x 5.2 mm² stator SRC | | ø16.6 | | | xx metre |
| 1 x 4 mm² grey | (AWG 12) | ø5.4 | | 0722 186 00536 | xx metre |
| 2 x 0.75 mm² screened | | ø6.5 | | 0712 187 00002 | xx metre |
| 3 x 0.2 mm² screened | | ø6.0 | | 0722 223 00002 | xx metre |
| 1 x 25 mm² PE | | ø9.0 | | 4512 152 31141 | xx metre |
| 1 x 16 mm² PE | | | | 4512 152 31121 | xx metre |
| 1 x 8.4 mm² FE/PE | (AWG 8) | ø7.6 | | 0722 186 00503 | xx metre |
| 1 x 6 mm² PE | | | | 4512 152 31241 | xx metre |
| 1 x 4 mm² PE | | | | 0722 186 00095 | xx metre |
| 1 x 16.7 mm² PE | | ø9.3 | | 4512 100 66131 | xx metre |
| 1 x 8.25 mm² PE | | ø6.82 | | 0722 186 00601 | xx metre |
| 8 mm – measuring chamber cable | 8 m | | | XC 5070 /08 | |
| | 12 m | | | XC 5070 /12 | |
| | 16 m | | | XC 5070 /16 | |
| | 20 m | | | XC 5070 /20 | |
| | 24 m | | | XC 5070 /24 | |
| | 28 m | | | XC 5070 /28 | |
| H.V. (03 – 03, 150 kV) | | ø16.5 | | 9806 402 6xx02 | (xx = length in m) |

### Orderinglist

| Codenumber | quantity |
|---|---|
| 2422 025 04936 | 10 pieces |
| 4512 126 25243 | 10 pieces |
| 2422 025 05039 | 1 piece |
| 2422 025 05038 | 1 piece |
| 2422 025 05456 | 1 piece |
| 2422 034 18334 | 1 piece |
| 4522 980 38051 | 1 piece |
| 4522 980 18141 | 1 piece |
| 4512 152 55244 | 1 piece |
| 4522 980 38031 | 1 piece |
| 2422 025 02991 | 1 piece |
| 4522 980 18041 | 1 piece |
| 4512 152 56761 | 1 piece |
| 4522 980 18081 | 1 piece |

A3 01–11–22 Schr./Ost.
4512982001 01_z7_10_010

4512 982 0010. (01.0)

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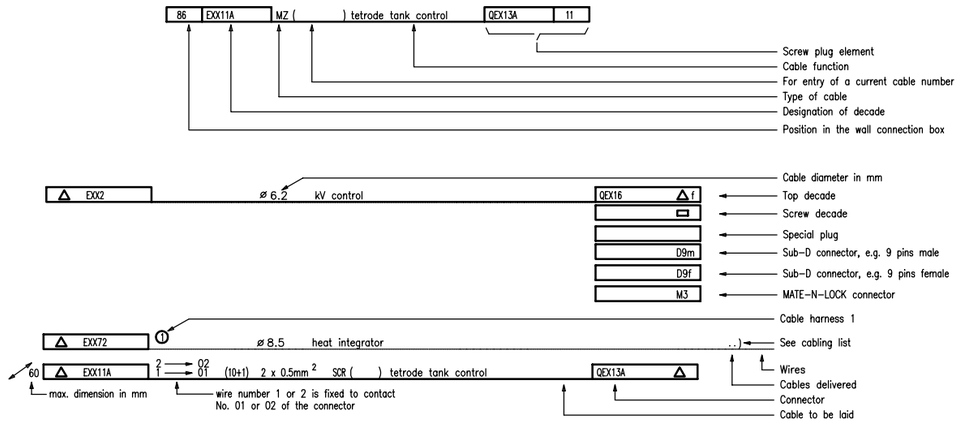
## – Heading symbols

| | |
|---|---|
| A | electronics cabinet angio |
| BL | electronics cabinet DSI |
| C | operators console |
| E | electronics cabinet X–ray generator |
| G | high tension tank frontal |
| GWB | H.V. changeover switch |
| HCU | hard copy unit |
| K | electronics cabinet TOMO |
| LHCU | laser hard copy unit |
| MC | wcb operators console |
| ME | wcb electronics cabinet X–ray generator |
| MK | wcb electronics cabinet TOMO |
| MON | monitor |
| MR | wcb electronics cabinet |
| MT | connection box wall bracket |
| MU | overhead connection box ceiling crane |
| R | electronics cabinet |
| S | bucky table |
| U | ceiling crane |
| UB | ceiling crane longitudinal carriage |
| UT | wall bracket |
| UZ | ceiling crane |
| vD | vertical DIAGNOST 1/2/4 |
| bD | bucky DIAGNOST VE/VT |
| VP | wcb bucky DIAGNOST |
| wcb | wall connection box |

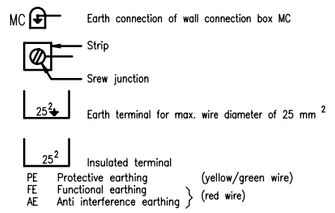
## – X–ray beam symbols

| | |
|---|---|
| BB | image intensifier |
| BD | image distributor |
| BK | I I camera |
| LA | collimator |
| SA | film plane |
| WK | TV camera |
| XA | X–ray tube |

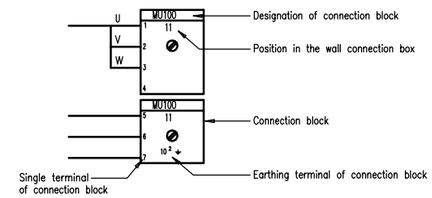
## – Cable symbols


86 EXX11A MZ ( ) tetrode tank control QEX13A 11
Screw plug element
Cable function
For entry of a current cable number
Type of cable
Designation of decade
Position in the wall connection box
Cable diameter in mm
EXX2 ø 6.2 kV control QEX16 f
Top decade
Screw decade
Special plug
D9m
Sub–D connector, e.g. 9 pins male
D9f
Sub–D connector, e.g. 9 pins female
M3
MATE–N–LOCK connector
Cable harness 1
EXX72 ø 8.5 heat integrator
See cabling list
60 EXX11A 2 01 (10+1) 2 x 0.5mm² SCR ( ) tetrode tank control QEX13A
Wires
Cables delivered
Connector
Cable to be laid
max. dimension in mm
wire number 1 or 2 is fixed to contact No. 01 or 02 of the connector

## – Earthing




## – Connection blocks




# Legend for earthing and cabling diagram

Z–7.10

# INSTALLATION

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# 1. Installing the wall junction box

- Mount the wall junction box at the place where the generator is intended to be installed.
  (See drawing “Connection of generator” in section 1 and manual UNIT 4512 103 75380 for wall junction boxes).
- If necessary, install the optional surge arrester WN inside the wall junction box.
  (See surge arrester documentation.)
- If applicable, mount the filler panels of the generator to the wall junction box.
- Have the mains cable present at the clinic connected to mains terminal MEX by a person who is authorized for this job.
- Check the phase sequence of L1, L2 and L3.

**Warning!**

**Switch OFF the mains supply present at the clinic and make sure that it cannot be switched ON again accidentally.**


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# 2. Mounting the H.V. generator in the cabinet

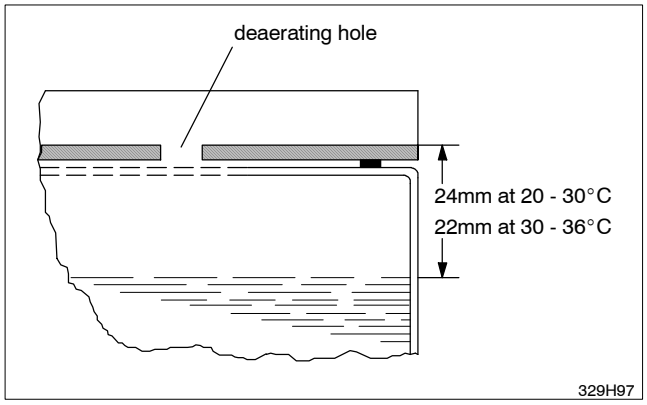
## 2.1. Mounting of the H.V. generator in the cabinet

**Caution!**
**Do not tilt the H.V. generator while transporting it.**

**In case of a tilting angle larger than 45°, the setting-to-work of the generator can be started not before a waiting time of about 8 hours has passed. Otherwise the H.V. generator may be destroyed by electrical sparkover.**

- Unpack generator cabinet E.
- In case the packing material is strongly soiled with oil check the oil level. Repair it if necessary.

  Tolerance: ±2mm
  Oil: Shell Diala G in 2.5l container
  4512 148 43172




- Remove the deaerating screw completely from the cover of the H.V. generator. Only this way the precision of the high voltage measuring divider corresponds to the specification.
  In case of return shipment of the H.V. generator this screw must be fixed again. Therefore, keep the screw laying on top of the cover.

**Caution!**
**Make sure that no foreign matter falls into the oil. Otherwise the transformer must be exchanged.**

- Take the two transport bars from the rear side of the cabinet.
- Lift the H.V. generator into the generator cabinet with the transport bars.
  The 4 connecting bolts GX1001 to 1004 must point at the front of the generator cabinet.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## 2.2. Electrical connection of the H.V. generator

- Connect the H.V. generator electrically:

| Generator version | Connection | | | Remark |
|---|---|---|---|---|
| | from | <---> | to | |
| 50/65/80kW | E1 (GND) | <---> | GX1100 (GND) | Ground |
| | ZX12 | <---> | G100X15 | Route the cables along the front and left-hand edge of the H.V. generator. Fix them. |
| | ZX35 | <---> | G100X14 | |
| 50kW | QC13:1 | <---> | GX1003 | Twist the cables!<br><br>**Note**<br>*The sequence of the connecting bolts is not in numerical order.*<br>*See drawing page 2-4.* |
| | QC03:1 | <---> | GX1002 | Push the screening cap forward over the connecting bolts and tighten it. Attach the converter cables including the screening to the screening cap with cable ties. |
| | GX1001 | <---> | GX1003 | The 50kW version might have direct links on each side or a link on one side and a choke of 1 ... 6 loops on the other side for the reason of kV symmetry.<br><br>**Note**<br>*Do not change these links or chokes.* |
| | GX1004 | <---> | GX1002 | |
| 65/80kW | QC13:1 | <---> | GX1001 | Twist the cables!<br><br>**Note**<br>*The sequence of the connecting bolts is not in numerical order.*<br>*See drawing page 2-4.* |
| | QC03:1 | <---> | GX1002 | |
| | 2QC13:1 | <---> | GX1003 | Push the screening cap forward over the connecting bolts and tighten it. Attach the converter cables including the screening to the screening cap with cable ties. |
| | 2QC03:1 | <---> | GX1004 | |


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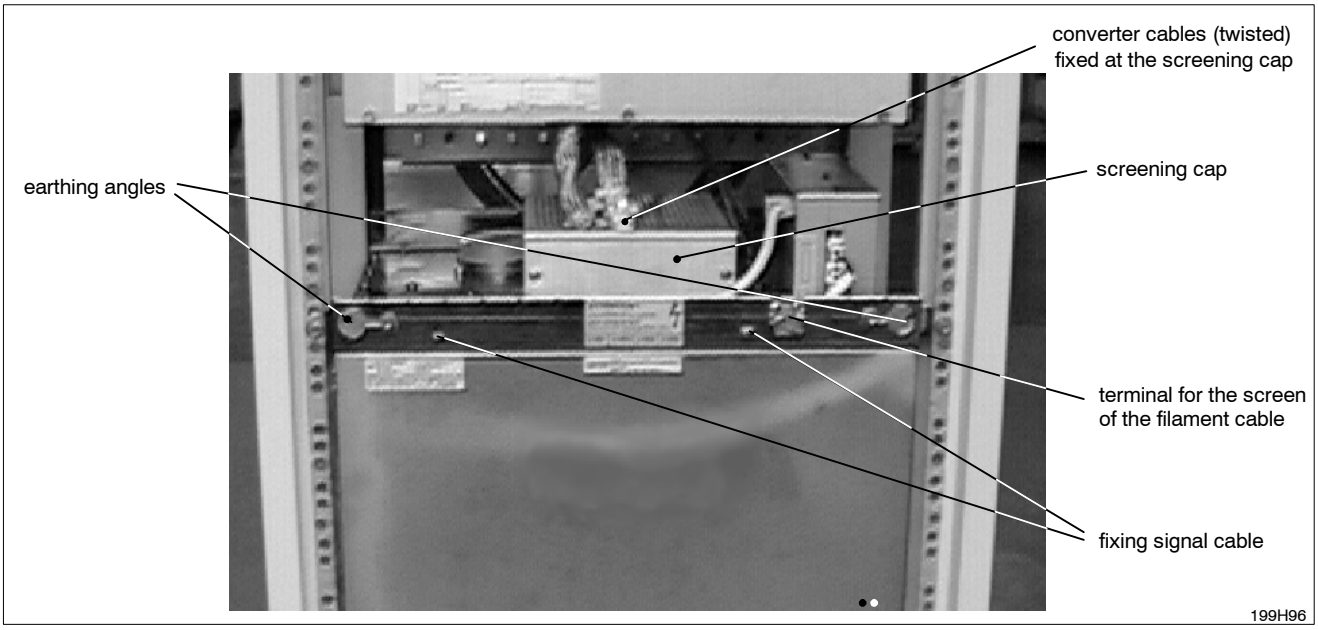
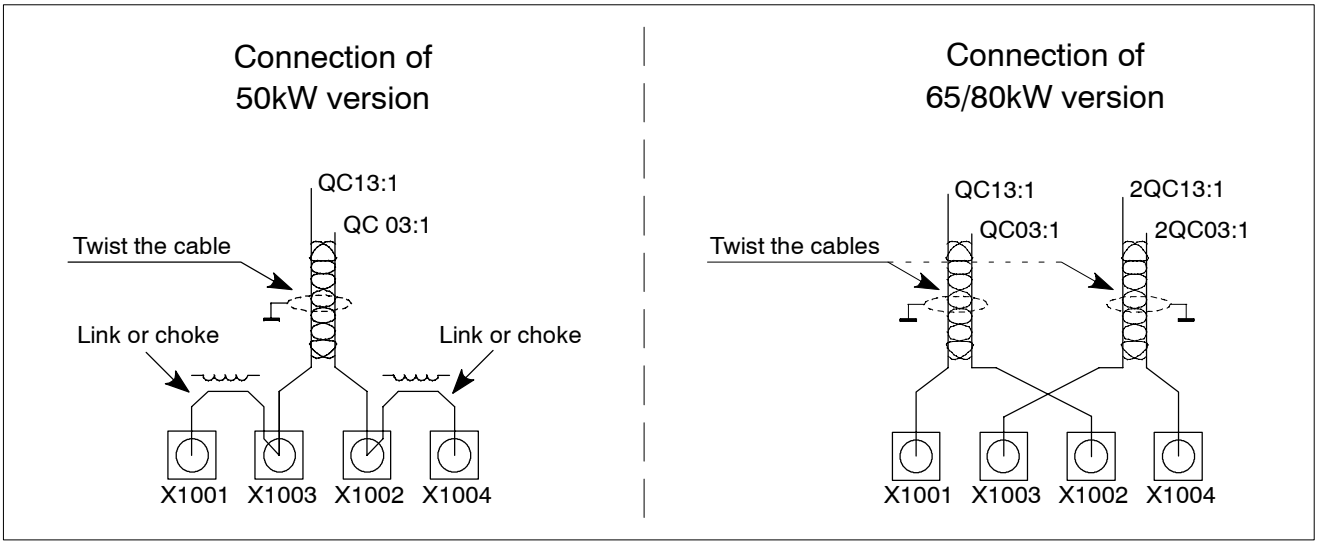
- Turn the two earthing angles of the H.V. generator outward and screw them on to the members of the cabinet.




## 3. Installing the operating panel

See Unit Manual COCKPIT for DuoDiagnost.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# 4. Electrical connection

## 4.1. Earthing

See ”Earthing diagram” in section 1.

## 4.2. Mains connection

### 4.2.1. Mains connection of the generator

**Warning!**

**Switch OFF the mains supply present at the clinic and make sure that it cannot be switched ON again accidentally.**

See ”Connection diagram” in section 1.

- Measure the internal mains resistance at the terminal MEX with a suitable measuring instrument.

  L1 - L2: $R_i$ = ..... mΩ
  L1 - L3: $R_i$ = ..... mΩ
  L2 - L3: $R_i$ = ..... mΩ

  Required max. mains resistance at generator input:

| Mains voltage | Mains resistance | | |
|---|---|---|---|
| | 30kW | 50kW | 65/80kW |
| 190V * | – | 40mΩ | – |
| 220V * | 130mΩ | 60mΩ | – |
| 240V * | 160mΩ | 80mΩ | – |
| 380V | 500mΩ | 300mΩ | 200mΩ |
| 400V | 500mΩ | 300mΩ | 200mΩ |
| 440V | 500mΩ | 350mΩ | 240mΩ |
| 460V | 500mΩ | 350mΩ | 240mΩ |
| 480V | 500mΩ | 400mΩ | 300mΩ |

***** with external mains transformer (max 50kW)

Maximum permissible internal mains resistance: 500mΩ

Internal resistance of **P**ower **D**istribution **U**nit PDU: 20mΩ at 50Hz
23mΩ at 60Hz


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**Caution!**
**Connect phase wires in correct phase sequence.**

- Connect the mains cable of the generator to terminal MEX: L1 / L2 / L3 within the wall connection box.
  If the optional **P**ower **D**istribution **U**nit **PDU** WT is fitted, connect the cables at that point to terminal WTX2.
- Connect the examination unit supply (max. 10A) to (230V / 400V):

| | | |
|---|---|---|
| Output 1 | Geometry power | ENX2101/...5 |
| Output 2 | I.I. / TV; GECO; UI; SYSCO | ENX2201/...9 |
| Output 3 | Imaging | ENX2301/...9 |

*(Output 3not switched by generator)*

### 4.2.2. Mains connection of the PDU

See delivered Unit Manual “Power Distribution Unit”.


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## 4.3. Stator connection

### 4.3.1. Shielding

**Caution!**
**To suppress interferences of the high-speed rotor control, the stator connections must be provided with a 360° screen at the tube and generator end.**

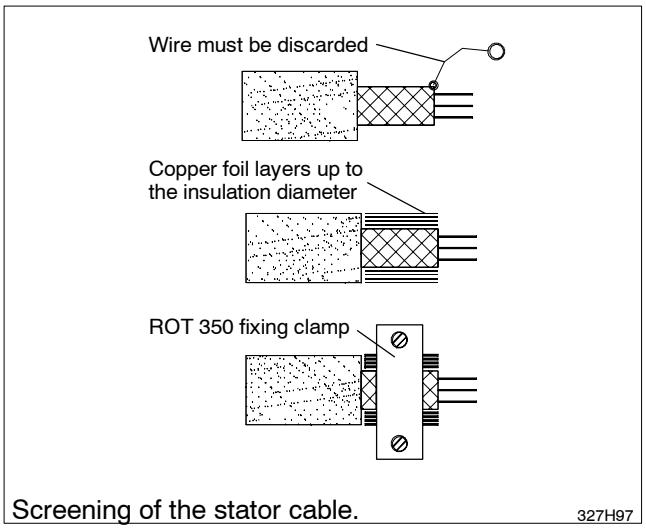
**General remarks:**

- SRM-0612 : . . . . . 3322 405 14191
- all othes tubes :

- Always use screened cables: . . . . 0722 215 02054.
- Shorten the stator cable to the required length. Do not accommodate excess lengths at the generator.
- Keep stator cable separate from all the other signal cables to avoid interference.
- Earth the screen at both cable ends.

**Screening procedure:**

- Remove any enamel or dirt from the clamp providing drag relief in the tube housing to make sure the clamp is conductive.
- Remove the plastic covering around the clamp, about 1cm (0.5”).
- Wrap copper foil around the visible screen of the cable until the original diameter of the cable is obtained.
- Remove the present red wire going from the screen end to the earthing point of the tube housing.
- Fix the screen of the stator cable with the clamp. Ensure that the clamp is secured and the ground contact works!



Screening of the stator cable. 327H97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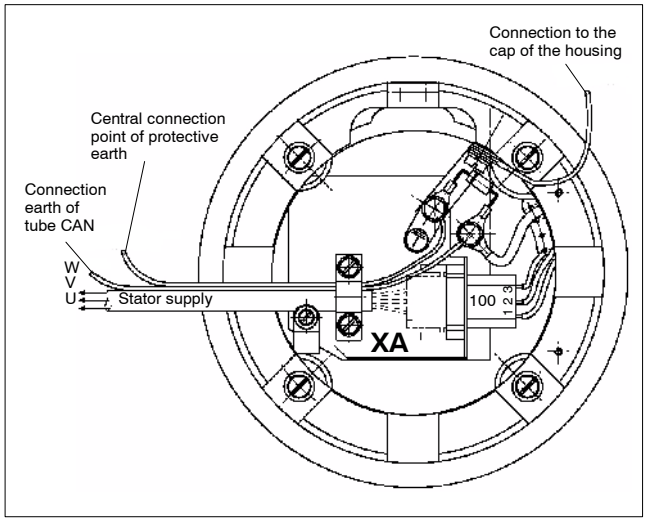
### 4.3.2. Connection

**Caution!**
**Do not mix up the phases, otherwise components of the rotor control may be destroyed.**

**At the tube end - only SRM-0612**

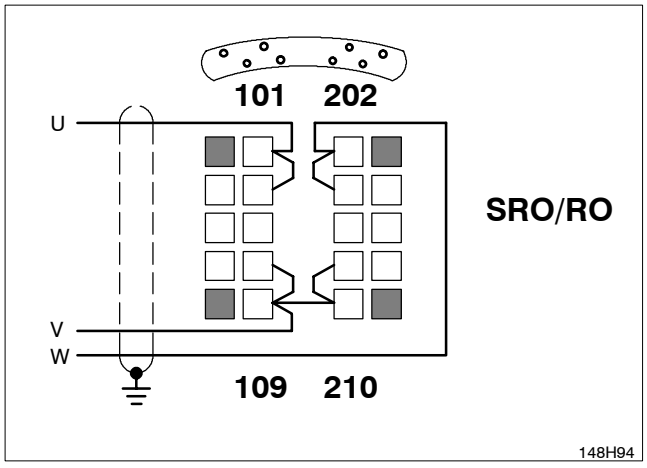
**Note**
*The following steps are valid for SRM 0612 tubes only.*

- Connect the stator cable with the MATE-N-LOCK connector.
- Connect protective earth and earth of tube CAN as shown in figure beside.
- Earth the screening of the stator cable at the tube housing with the metallic clamp.




**At the tube end - all other tubes**

- Place the jumpers across terminals 100 and 200 according to the figure.




- Connect the stator cable:
  wire 1 ---> phase U
  wire 2 ---> phase V
  wire 3 ---> phase W

- Earth the screening of the stator cable at the tube housing with the metallic clamp.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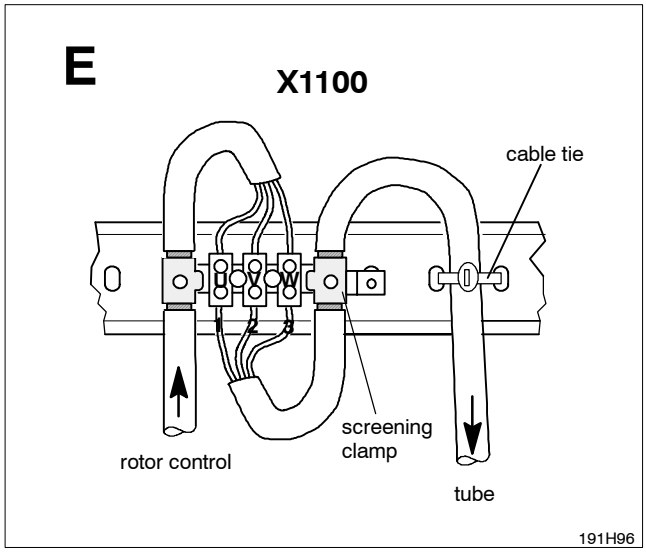
**At the generator end**

See ”Connection diagram” in section 1.

- Connect the stator cable to the terminal EX1100 (U–V–W).
- Check the stator connection by measuring the resistances:
  U – V = wire 1 – 2 ≈ 11Ω
  U – W = wire 1 – 3 ≈ 20Ω
  V – W = wire 2 – 3 ≈ 9Ω
- If an inductance meter is available, measure the following inductance values:
  U – V = wire 1 – 2 = 57mH ±10%
  V – W = wire 2 – 3 = 34mH ±10%
- Fix the screen below the screening clamp.
- Relieve the tension of the stator cable by a cable tie.




## 4.4. Signal cables

See: – ”Connection diagram” in section 1.
– Z1–6 ”Basic interface” in section “Schematic drawings”

### 4.4.1. Room decade cable

- Connect the door switches at the generator:

  EZX1: 8 <---> switch <---> 10

  or

  EWBX22: 8 <---> switch <---> 10

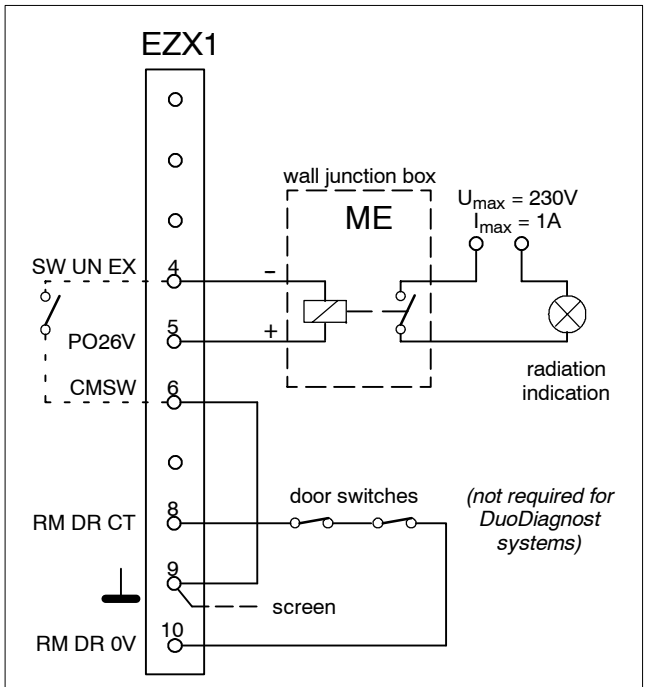
  In case no switch is present
  link: pin 8 <---> pin 10

EZ150 K1:

max. switching and loading current = 1A

max. Load = 60VA AC
= 30W DC

**Caution!**
**Make sure the polarity of the relay is correct.**



Door switch connection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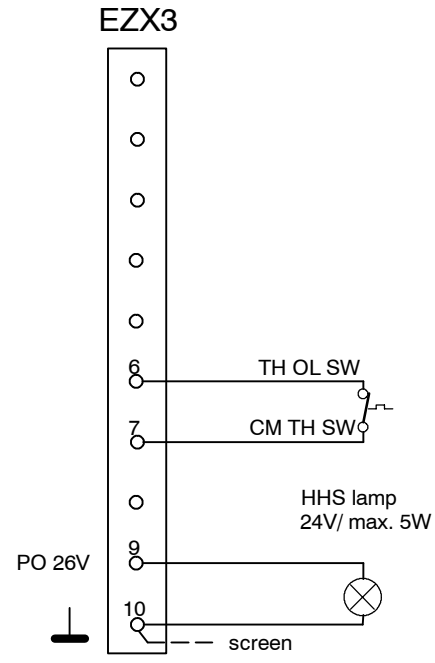
### 4.4.2. Tube supervision

- Connect the thermal switch or the thermal sensor of the tube housing assembly.

**For U.S.A. and U.K. only:**

- Connect the HHS-lamp to indicate the selected tube housing assembly.




Tube supervision connection

### 4.4.3. CAN interface

- For examination units which are provided with a CAN system interface connect:
  - EZX 23 – signalbus
  - EZX 43 – system CAN

### 4.4.4. Dose input

- Connect the measuring chambers to the D-Sub connectors EZX21/22.
  EZX31/32/41 are not used.

  **Note**
  *There are restrictions on assignment because the measuring chambers are assigned to certain auxiliaries in SW programming of COCKPIT.*

### 4.4.5. Dose rate input

- Connect the dose rate output of TV chain for fluoroscopy at EZX61.
  Use the I.I./TV adapter on EZX61.
  See also drawing Z1–5.1 ”Central unit”.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## 4.5. H.V. cables generator side

See ”Connection diagram” in section 1.

- Mark the H.V. cables at the generator and the tube end with the correct polarity.
- Fix the H.V. cables on the left-hand side of the wall junction box on the middle rail to provide drag relief for the cables. The short ends of the H.V. cables which are going to the H.V. generator must be routed in downward direction in this area.
  The free cable lengths including plugs have to be about 1.5m.
- Twist the H.V. cables counter-clockwise by one turn and connect them to the H.V. generator.
  The twisting of the cables allows that the H.V. cables can be put into a loop when the cabinet is placed against the wall.
- Check whether the H.V. sockets are filled with some oil. At least the lower half of the plugs must be wet with oil.

**Caution!**

**Do not use a silicone washer.**

**Do not grease the plugs with silicone.**

**The union nuts of the high-voltage connectors must be tightened up to ensure good electrical contact for screening.**

**Only high-voltage connectors which have threaded flange halves may be used.**
**Older high-voltage cables still have connectors where the flange halves are kept together with a spring washer.**
**In such cases the modification kit 4512 103 8085x is required.**

## 4.6. Emergency-OFF circuit

- Connect the emergency-OFF buttons to EZX4:1/2.
  If not necessary, link pins 1 - 2.

  See Z1-2.1 ”Power supply” in “Schematic drawings” section and Z2-5.2 “Backpanel Basic rack-2Z” in the “Wiring diagrams” section.


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# 5. Hardware programming

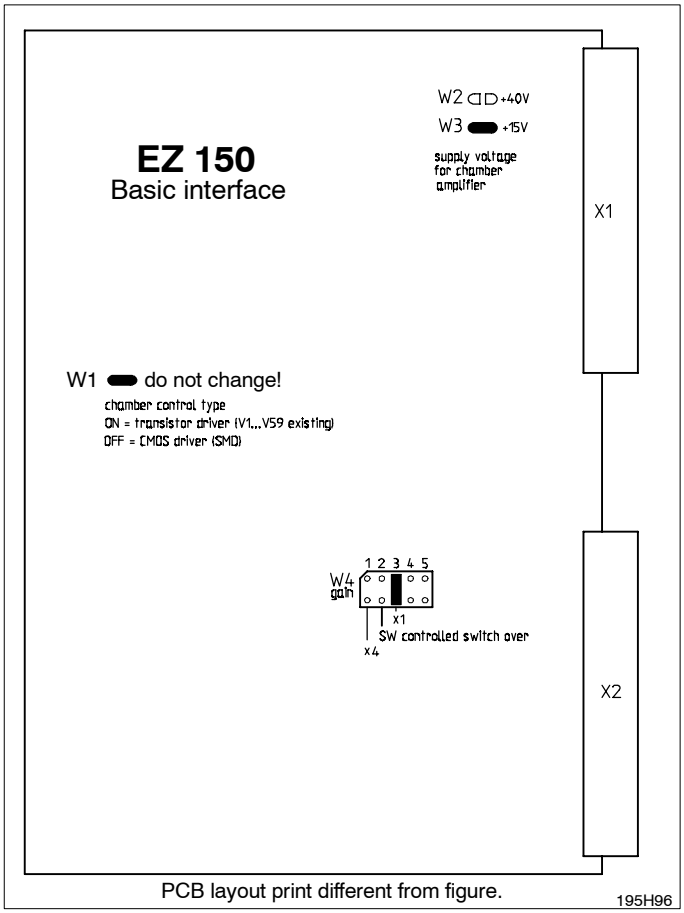
Programmings on PCB EZ150 basic interface:

**Note**
*Never change jumper W1.*

- Voltage supply for the amplifiers of connected measuring chambers:

| Voltage | Soldering link | |
|---|---|---|
| | EZ 150 W2 | EZ 150 W3 |
| 15V default | OFF | ON |

Working voltage range for ALC measuring chambers: 15 ... 45V



PCB layout print different from figure.
195H96

- Set the gain factor for AEC techniques with jumper EZ150:W4:
  - Factor 1 ==> W4 in position 3 = default
    For screen/film combination with at least one system speed ≤ 200.
  - Factor 4 ==> W4 in position 1
    For screen/film combinations with all system speeds > 200.

- The software programming has to be set accordingly.

The rest of the generator hardware has been properly programmed at the factory.
If required, refer to section 5: PROGRAMMINGS.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# 6. Switch-ON of the generator

- Switch ON the fuses present at the clinic.
- Switch ON automatic circuit-breakers ENF1, ENF2 and ENF3.

  The yellow LED on EN100 power ON circuit must be illuminated.

# 7. Installation software XRGSCOPE

## 7.1. PC and generator settings to avoid problems during up/downloading of CU complete files

Any kind of interruption can cause the loading process to fail.

Problems occur mainly during the download to the PC.

A download file which is not complete cannot be used as a safety backup file.

Start XRGSCOPE always from DOS if possible.

When using any WINDOWS version:

- Switch OFF all screensavers.
- Do not run other programs.
- Do not insert any CD in the drive.

Any kind of power management of the PC hardware (BIOS) as well as the windows power management should be switched OFF.
If connected to mains power some of these might be automatically OFF.


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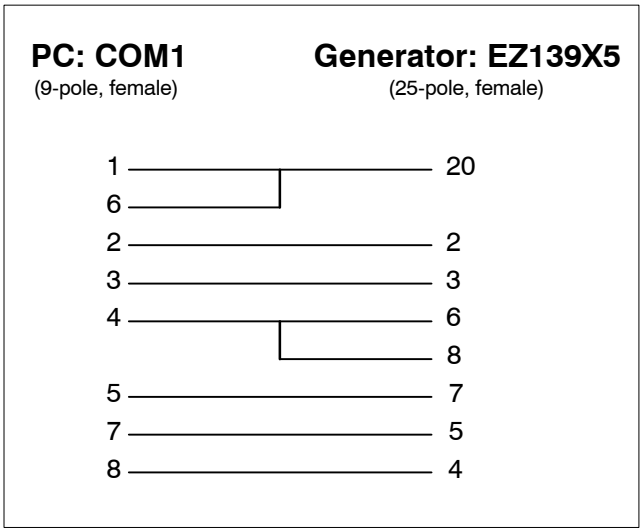
## 7.2. Installation procedure

- Provide the service PC with the hardware key and switch it ON.
  The hardware key provides access to special program settings and to menu ***"Faultfind".***
  Standard programming is possible without a hardware key.
- Connect the PC to X5 on EZ139 CENTRAL UNIT CU via a serial data cable.
  A 5m long data cable can be ordered via 12NC: 4512 130 5693x.
  Data cable Optimus C Rel. 1.x for DuoDiagnost with handshake can also be used for Optimus RAD and R/F Rel. 3.x.




- Insert the floppy disks containing the self-unpacking exe-files of the firmware in the disk drive of the PC:
  OMC: 4512 116 024xx
  For unpacking on the harddisk of the PC about 5MB are needed.
- Generate a directory e.g. [C:\OPT_C] on the PC by entering **<md C:\OPT_C>** or use WIN commands.
- Copy the firmware from both floppy disks to the PC into the same directory C:\OPT_C by entering **<copy A:*.* C:\OPT_C>** or use WIN commands.
- Start unpacking the programs by entering **<OMCxxxxx.exe>** or doubleclick on **<*.exe>** -file.
  The programs unpack all files needed for the update of the firmware and the newest service tools.
- After unpacking [OMCxxxxx.exe] can be deleted on the harddisk by entering **<del OMCxxxxx.exe>**.
- For the current contents of [OMCxxxxx.exe] read [OMCxxxxx.txt] on the floppy disk.
- For a new installation of the generator firmware see section 4 REPLACEMENT, chapter 4 "Exchange or update of firmware ...".
- Call the installation program by entering ***<xrgscope>*** or ***<xrgscope lcd>*** for PCs with LCD screen.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- Start with an XRGSCOPE–screen CUSTOMER.tdl with data which are actually stored in CUSTOMER.tdl.
  Enter “XRGSCOPE customer”.
  Whenever data screens like *’error log index’* are saved to an xxx.tdl file (function **save <F3>** appears in the bottom line), *‘Customer Data’* being saved in the CUSTOMER.tdl file are attached to the saved data screen. It helps to separate saved screen files of different sites, customers or rooms in the same hospital.
  Site data must be stored in CUSTOMER.tdl file, only data of this file are attached to the saved screens. One can save site specific customer data in self-made files using **<F3>**. To recall site data use the **load <F4>** function.

  Procedure:
  Either the CUSTOMER.tdl screen is open or open the *‘Customer Data’* screen. Push **<F4>** and select a site data file. The old data screen comes up. Now save this screen with **<F3>** entering in CUSTOMER as file name.

  - **Customer Name:**
  - **City** / **State:**
  - **Country:**
  - **Generator Location:**
  - **Generator Serial Number:**
  - **Generator 12 NC:**
  - **Memo1:**
  - **Memo2:**
  - **Memo3:**

  After **<ESC>** the following menu line appears:

| *File* | *OPTIMUS C* | *Select Unit* | *Options* | *Help* |
|---|---|---|---|---|

- Select ”OPTIMUS C”.

  The following menu line appears:

| *Program* | *Adjust* | *Accept* | *Faultfind* | *Quit* |
|---|---|---|---|---|


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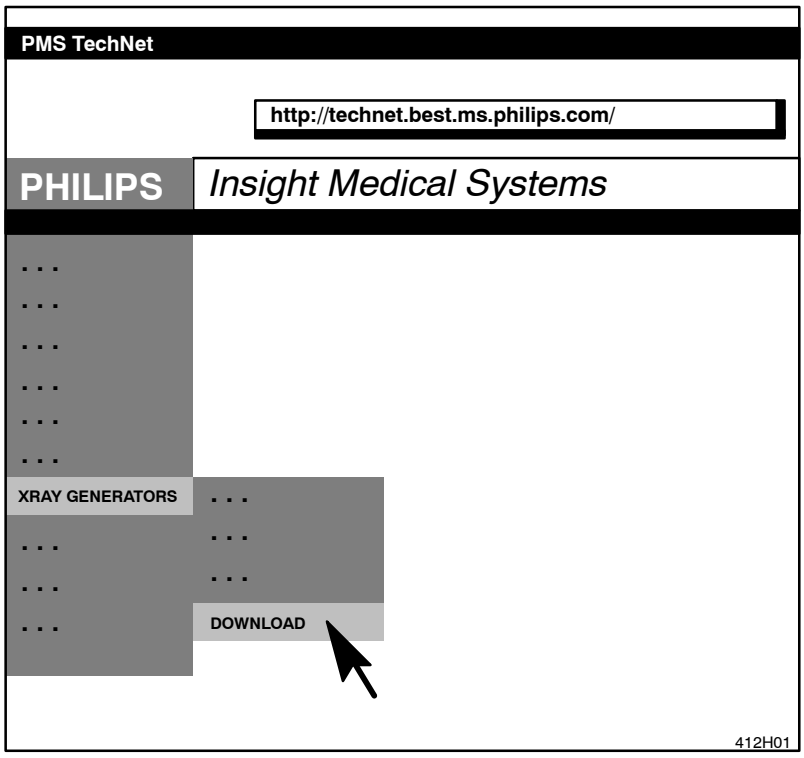
General information:

- Button **<F1>** **<help>** Call help / cancel help.
- Button **<F2>** **<transmit>** Store screen contents / data set in the generator ==> transmit to generator.
- Button **<F3>** **<save>** Store data screen on disk.
  For an open data screen the path desired can be selected.
- Button **<F4>** **<load>** Load data set from disk.The desired path can be selected.
- Button **<ESC>** Commands one step back. Can be used repeatedly.
- Fields with ↓ Select the possible range of values by pushing **<RETURN>**.
  The data are specified by the generator as fixed values.
- Fields with **[...]** Input of data via the keyboard.

Error numbers which appear at the beginning of the programming procedure must be erased from the screen by pushing the **<RETURN>** key.

Current data files, for instance, for online help, tube types, APR programming are available in the PHILIPS-Intranet. Use path: ***http://technet.best.ms.philips.com/*** and pull down menu as shown below.




If the installation program is called with **<xrgscope ?>** the possible starting parameters for the service program are listed.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# 8. Setting-to-work overview

**Note**
*The programming of a generator must take place in the sequence specified below.*

- Switch the generator ON.

8.1. Configuration

8.2. Tube adjustment
- RESET the generator

8.3. Dose rate control
- RESET the generator

8.4. Application limits
- RESET the generator

8.5. Area exposure product calculation (option). *Function not applicable for DuoDiagnost.*

8.6. Acceptance test

8.7. Backup of all configuration data

## 8.1. Configuration

- Switch the generator ON.

### 8.1.1. Date and time

- Select menu:
  PROGRAM/ **DATE AND TIME**
- Enter the respective local data.

### 8.1.2. Mains data

- Select menu:
  PROGRAM/ **MAINS DATA**
- Select the nominal value of the mains voltage U.
  Range: 380V, 400V, 440V, 480V
  Default: 400V
  If 460V is present program 480V.
  If 415V is present program 400V.
- Enter the maximum internal mains resistance $R_i$.
  Range: 0 ... 500mΩ

Depending on the internal mains resistance and the mains voltage the generator calculates the maximum possible output.


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### 8.1.3. Tube data set

- Select menu:
  PROGRAM/ TUBES/TUBE 1 ... 3/ **TUBE 1**
- Start the displayed file *TUBExxx.tdl* with **<RETURN>**.
  All the permitted combinations of tube type and housing type are listed in a window.
- Select the respective combination of tube type and housing type from the list and push **<RETURN>**.
- RESET the generator.
  The data which have been configured up to now are read by the processor when the system is started.

### 8.1.4. Tube speed selection

Depending on the type of tube loaded the anode speed is automatically programmed.

**Caution!**
**Wrong programming can cause tube problems.**

- Select menu:
  PROGRAM/ TUBES/TUBE 1 ... 3/ **TUBE 1**

| **Rotation** | **RPM \ tube type** | |
|---|---|---|
| | **RO** | **SRO** |
| **Exposure rotation [RPM]** | 3000 | 9000 |
| **Fast exposure rotation [RPM]** | n/a | n/a |
| **Fluoroscopy rotation [RPM]** | 3000 | 3000 |

### 8.1.5. Tube limits

- Select menu:
  PROGRAM/ TUBES/ **TUBE LIMITS**
- Program the maximum working voltage which is indicated on the data label:

  Max. tube voltage limit
  Range: 40 ... 150kV
  Default: 150kV

  Adaptation of the tube takes place only up to this limit.

After adaptation of a tube the upper kV limit is displayed for each focus of each tube under:
Adapted to [kV]: e.g. 125kV

All the other limit programmings are performed by the generator automatically and do not usually have to be observed.


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### 8.1.6. Capacitance of tube connection

- Select menu:
  PROGRAM/ TUBES/ **CAPACITANCE TUBE CONNECTOR**

Range: 2.000 ... 10.000nF

The total capacitance for each tube connected is indicated:

$C = \frac{1}{2} (C_{H.V.\ generator} + C_{H.V.\ cable})$

= 4.550nF Default for H.V. generator + 20m H.V. cable (155pF/m)

$$C\ [nF] = 3 + \frac{C_c \times L}{2000}$$

$C_c$ = specific cable capacitance in [pF/m]
L = single cable length in [m]

| Single length [m] | Capacitance tube connection [nF] | |
|---|---|---|
| | For 155pF/m cable | For 200pF/m cable |
| 14 | 4.085 | 4.400 |
| 16 | 4.240 | 4.600 |
| 18 | 4.395 | 4.800 |
| 20 | 4.550 | 5.000 |
| 22 | 4.705 | 5.200 |
| 24 | 4.860 | - |
| 26 | 5.015 | - |
| 28 | 5.170 | - |
| 30 | 5.325 | - |

The high-voltage cables type 9806 402 6xx02 currently being supplied have a capacitance of 155pF/m.


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### 8.1.7. Tube operating modes

- Select menu:
  PROGRAM/ TUBES/ **TUBE OPERATING MODE**

  - Intermediate boost:

    Select ... Disable = During preparation the rated filament current is applied (default).

    Enable = During preparation a reduced filament current is applied.
    After the release of exposure boosting takes place for a short time before the exposure is released. Effective with tube currents > 80% of max. value.

  - Rotation prolongation after PREP:

    Select ... Disable = The tube is braked as soon as preparation has been cancelled.

    Enable = After cancellation of preparation the tube is only braked after 30s. Within this time preparation can be repeated as often as necessary.
    Recommended for paediatrics and casualty rooms.

### 8.1.8. Disable tube

For correction of the configuration.

- Select menu:
  PROGRAM/ TUBES/ **DISABLE TUBE**

When the tube is disabled the above stored data set of the tube is erased. To enable the tube the data set has to be loaded again.


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## 8.2. Tube adjustment

### 8.2.1. Tube conditioning

**Warning!**
**Radiation is released during the conditioning procedure!**

- RESET the generator. It must be in READY state.
- Select free cassette auxiliary.
- Select **large** focus only.
- Run reconditioning procedure for an adapted tube, refer to following table, left column TUBE ADAPTED.

or

- Run conditioning procedure for a new or non-adapted tube, refer to following table right column TUBE NOT ADAPTED.
- It is recommended that the high tension be monitored during conditioning.
  Connect the scope:
  Channel1: kV AV HT at EZ130 X3 (1V/div), scale: 20kV/V
  Trigger external: CTRL_X_C/ at backpanel EZ X74, negative slope
  Time base: 2ms/div
- In case of problems like tube arcing see the following flowchart EXPOSURE SEQUENCE as an example.
  The flowchart applies for applicable kV range only, e. g.:
  109kV is the max. kV value for normal application, perform just up to next higher kV step = 117kV.

**Note**
*Refer to* flowchart EXPOSURE SEQUENCE.
*If the tube arcs at a certain kV value, switch another 3 exposures with same parameters and 10s pause between subsequent exposures. In case of success (no arcing anymore) continue with next kV step of the following table.*
*If the last exposure still arcs go one kV step back and follow normal procedure. If this routine has been performed three times without improvement:* ==> **Replace the tube!**


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| Exposure parameters for conditioning | | | | | |
|---|---|---|---|---|---|
| Tube adapted | | | # exposures | Tube not adapted | |
| kV | mA | ms | | kV | mAs |
| 80 | 10 | 50 | < 1 > | 80 | 0.5 |
| 80 | 10 | 500 | < 1 > | 80 | 5 |
| 80 | 200 | 250 | < 1 > | 80 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 80 | max. mA | 100 | < 1 > | 80 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 90 | 10 | 50 | < 1 > | 90 | 0.5 |
| 90 | 10 | 500 | < 1 > | 90 | 5 |
| 90 | 200 | 250 | < 1 > | 90 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 90 | max. mA | 100 | < 1 > | 90 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 100 | 10 | 50 | < 1 > | 100 | 0.5 |
| 100 | 10 | 500 | < 1 > | 100 | 5 |
| 100 | 200 | 250 | < 1 > | 100 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 100 | max. mA | 100 | < 1 > | 100 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 110 | 10 | 50 | < 1 > | 110 | 0.5 |
| 110 | 10 | 500 | < 1 > | 110 | 5 |
| 110 | 200 | 250 | < 1 > | 110 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 110 | max. mA | 100 | < 1 > | 110 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 120 | 10 | 50 | < 1 > | 120 | 0.5 |
| 120 | 10 | 500 | < 1 > | 120 | 5 |
| 120 | 200 | 250 | < 1 > | 120 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 120 | max. mA | 100 | < 1 > | 120 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 130 | 10 | 50 | < 1 > | 130 | 0.5 |
| 130 | 10 | 500 | < 1 > | 130 | 5 |
| 130 | 200 | 250 | < 1 > | 130 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 130 | max. mA | 100 | < 1 > | 130 | 100 |
| 1 minute pause | | | | 1 minute pause | |


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| Exposure parameters for conditioning | | | | | |
|---|---|---|---|---|---|
| Tube adapted | | | # exposures | Tube not adapted | |
| kV | mA | ms | | kV | mAs |
| 140 | 10 | 50 | < 1 > | 140 | 0.5 |
| 140 | 10 | 500 | < 1 > | 140 | 5 |
| 140 | 200 | 250 | < 1 > | 140 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 140 | max. mA | 100 | < 1 > | 140 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 145 | 10 | 50 | < 1 > | 145 | 0.5 |
| 145 | 10 | 500 | < 1 > | 145 | 5 |
| 145 | 200 | 250 | < 1 > | 145 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 145 | max. mA | 100 | < 1 > | 145 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 148 | 10 | 50 | < 1 > | 148 | 0.5 |
| 148 | 10 | 500 | < 1 > | 148 | 5 |
| 148 | 200 | 250 | < 1 > | 148 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 148 | max. mA | 100 | < 1 > | 148 | 100 |
| 1 minute pause | | | | 1 minute pause | |
| 150 | 10 | 50 | < 1 > | 150 | 0.5 |
| 150 | 10 | 500 | < 1 > | 150 | 5 |
| 150 | 200 | 250 | < 1 > | 150 | 50 |
| 10 seconds pause | | | | 10 seconds pause | |
| 150 | max. mA | 100 | < 1 > | 150 | 100 |
| 1 minute pause | | | | 1 minute pause | |



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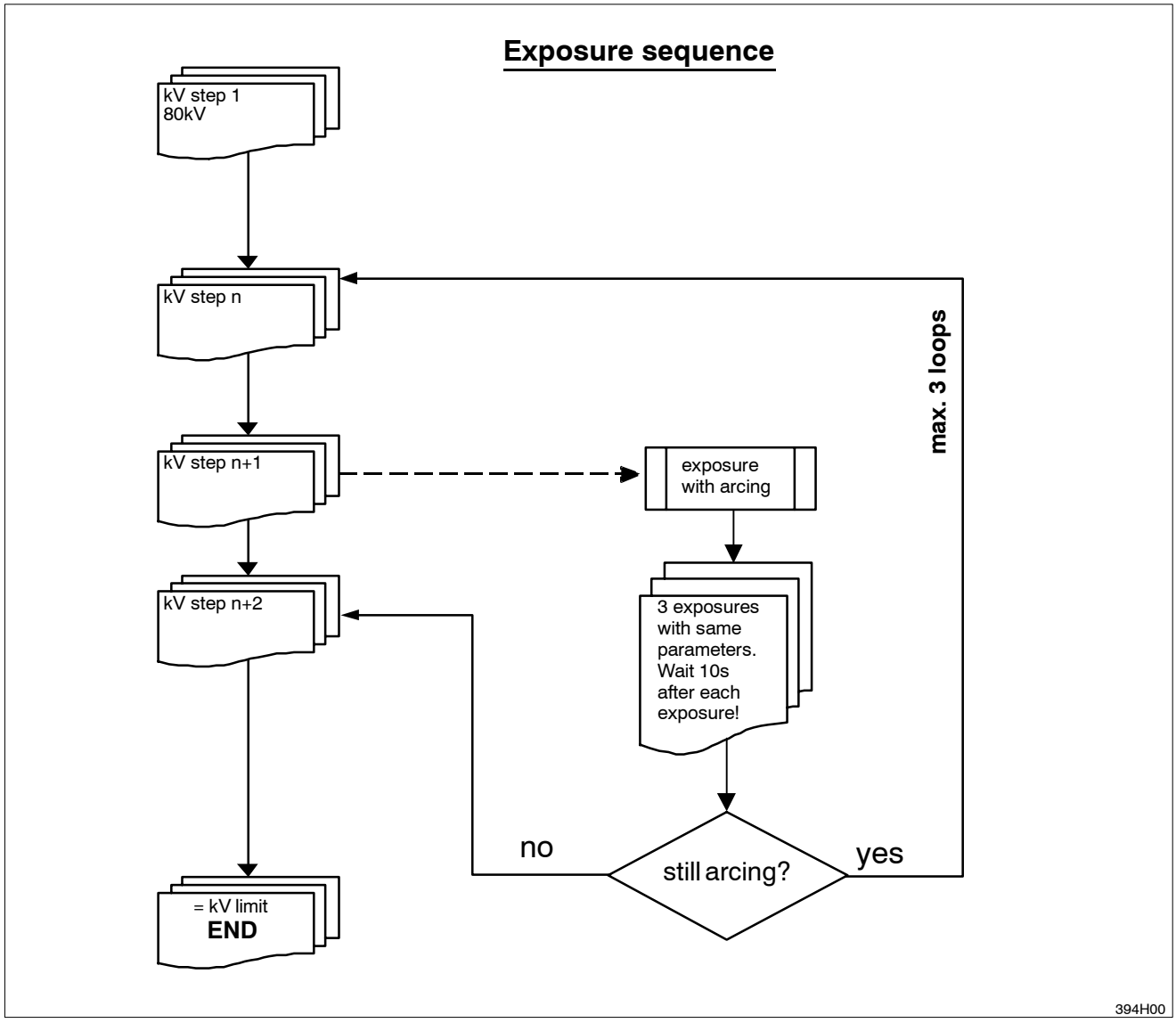


**Note**

*If the tube arcs at any kV value which is not required for application the max. kV (e.g.117kV) program this new limit value by* XRGSCOPE:
PROGRAM/ TUBES/ TUBE LIMITS/ MAX. TUBE VOLTAGE LIMIT [kV]/ **[117]**

As the limit value decreases for this reason, a following re-adaptation procedure sets the field ADAPTED TO [kV] to this value as well.

- Set RGDV programming to original status if no adaptation procedure has to be executed.
- RESET the generator.


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### 8.2.2. Tube adaptation

**Warning!**
**Radiation is released during the adaptation procedure!**

**Note**
*The tube must be properly conditioned before the adaptation procedure is started.*
*For break-in procedure see previous chapter 8.2.1. "Tube conditioning".*

Tube adaptation is an automatic process which includes:

1. The measurement of the mA offset of
   - the kV measuring circuit.
   - the emission current voltage / frequency converter.

2. The measurement of the individual standby filament current.

3. The kV dependent filament / emission current behavior.

4. The boost adaptation to calculate the positive and negative boost in one procedure.
   For more information refer to section 3: FAULT FINDING.

**Note**
*In case of problems check the symptom / solution list at the end of this chapter.*
*Repeat the adaptation for this particular focus.*

- Press **<RETURN>**.
  An opening screen asks to wait 20 seconds after the screen comes up.
- Press **<F2>** to transmit the data.

**Tube:** **1st Tube**
**2nd Tube** not applicable
**3rd Tube** not applicable

**Focus:** **small**
**medium** a tube with a (third) medium filament does not exist yet, it is **not** VARIOFOCUS
**large**


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After data transmission COCKPIT displays **[Adaptation X-Ray tube]** (locally programmed language).
READY returns (waiting time is about 15 seconds).

- Push **<PREP>** and **<EXP>** button at the control desk or use footswitch.

The generator switches about 125 exposures for each focus.
The radiation sign at the desk indicates exposures and a beep is audible at the end of every exposure.
There is no display of the actual kV parameters during adaptation.

The termination of the adaptation procedure is indicated at the PC screen and a beep from the PC is audible.

- RESET the generator.

- Adapt **both** small and large focus to use VARIOFOCUS.
  APRs using VARIOFOCUS cannot be selected as long as **both**, small and large are not adapted.
  The COCKPIT screen indicates a non-adapted focus.


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**Problems during adaptation - Symptoms and solutions**

1. A warning cannot be displayed on the control desk, the **[WAITING]** screen on the PC is flickering instead during this event and logged in the error log index.

2. If the tube has already been at a high temperature level (but the tube load indication still indicates green or green-yellow for 100% power) it might happen that the load indication changes straight to red and the adaptation is on hold**.**
   **[WAITING]** is flickering on the PC.

   Solution: Keep the handswitch pushed, once the temperature is down adaptation continues automatically.

   **Note**
   *An increment of one of the temperature levels inhibits the 100% power condition. This event is always logged as warning 00BV in the error log index.*

3. An error message just flashes for a very short moment and is instantly covered by **[ADAP]** on the desk afterwards.
   **[WAITING]** is flickering on the PC.

4. All buttons at the control desk including the RESET button are inactive during adaptation.
   The only way to RESET an error is to release the PREP switch which causes an interrupt similar to the RESET command.

5. After letting go of the PREP switch wait until the desk indicates **[READY]**. If **[READY]** does not appear at least after 20 seconds run a warmstart of the generator by pushing the RESET button on CU EZ139.

6. If adaptation seems to do nothing for more than 30 seconds let go of the PREP switch. Wait until the desk indicates READY. If **[READY]** does not appear at least after 20 seconds run a warmstart of the generator by pushing the RESET button on CU EZ139.

7. If a constant **[READY]** indication appears for more than 2 seconds while PREP and EXP is activated by the handswitch during adaptation let go of the handswitch.
   Wait until the desk indicates **[READY]**. If **[READY]** does not appear at least after 20 seconds run a warmstart of the generator by pushing the RESET button on CU EZ139.

8. If adaptation does not carry on with or without **[READY]** indication check whether one of the function units indicates a FATAL error by turning on the red LED. Let go of the handswitch and run a warmstart of the generator by pushing the RESET button on CU EZ139.

9. If adaptation has been interrupted by a generator warmstart check the error log index before restarting adaptation: kV errors 02WG and/or 02WH indicate tube arcing.
   In this case run conditioning of the tube as described in chapter 8.2.1 and/or reduce the max. kV value to the required application value.


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## 8.3. Dose rate control

### 8.3.1. AMPLIMAT sensitivity

- Select menu:
  PROGRAM/ DOSE RATE CONTROL AMPLIMAT/ **SENSITIVITY**

- Depending on HW programming of jumper EZ150:W4. W4 programs sensitivity accordingly:

  high = × 4 = EZ150:W4 in position 1
  ===> All screen/film combinations with a system speed > 200.

  low = × 1 = EZ150:W4 in position 3
  ===> At least one screen/film combination with a system speed ≤ 200.

### 8.3.2. Screen/film combinations

5 screen/film combinations can be programmed for each of the 5 measuring chambers:

- Select menu:
  PROGRAM/ DOSE RATE CONTROL/ AMPLIMAT CHAMBER 1 + 2/ **DATA SET 1 ... 5**

  The number of the chamber corresponds to the specified unit number of the dose measuring unit.

The choice between automatic and manual DRC processing is possible when an authorized hardware key is inserted in the PC.

Automatic is selected as default and must be used for the initial programming.
Data sets of adjacent rooms can be copied but have to be aligned afterwards.

Access manual DRC processing by pushing the **<ESC>** key.
The manual mode is suitable for:

- Copying complete programming to other measuring chambers.
- Setting the basic density.
- Changing the desk-displayed names of the programmed screen/film combinations.
- Creating backups of the DRC programmings.


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#### 8.3.2.1. Automatic DRC processing

- Select the desired data from the files offered for the following programming steps.

  The files are part of the installation software.
  - Select the programming field with the cursor and enter **<RETURN>**.
  - Enter the desired file from the list offered.
  - Select the desired data as required.

| | | |
|---|---|---|
| **FILM:** | File **FILM.TDL** | Film types according to description of the manufacturer. |
| | File **FILM_BL/ _GR/ _UV.TDL** | General classification of the film according to color, sensitivity S and RLF compensation. |
| **SCREEN:** | File **SCREEN.TDL** | Screen types according to description of the manufacturer. |
| | File **LUMAT_LG.TDL** | - Screen types according to luminous matter.<br>- Imaging plates. |
| **CHAMBER:** | File **CHAMBER.TDL** | Different types of measuring chambers. |
| **CASSETTE:** | File **CASSETTE.TDL** | Different types of cassettes. |
| **SYSTEM CORRECTION:** | File **SYSCOR.TDL** | Select **no corr. (ISO 9236-1)** |
| **CORRECTION FACTOR:** | Default **1.00** | Correction factor for switch-OFF dose. |

Based on the combination of the components entered, the processor calculates the switch-OFF dose, kV correction and RLF compensation. The name for the screen/film combination, e.g. ”B400”, is taken from the “screen” default data set.

**Dose Rate Control setting Optimus for Computed Radiography (PCR or other imaging plates)**

The following example is for a 400 speed system, determined by the selection of the LG06 400 speed type from file LUMAT_LG.TDL (luminous groups).
Ignore the violet screen colour of LG06, the data set just requires its kV characteristic.

| | | |
|---|---|---|
| **FILM:** | File **FILM.TDL** | **X-CONSTANT RLF=1** |
| **SCREEN:** | File **LUMAT_LG.TDL** | **LG06 S400 vi** |
| **CHAMBER:** | File **CHAMBER.TDL** | *the installed chamber type* |
| **CASSETTE:** | File **CASSETTE.TDL** | **normal cassette (def)** |
| **SYSTEM CORRECTION:** | File **SYSCOR.TDL** | **no corr. (ISO9236-1)** |
| **CORRECTION FACTOR:** | | **1.00** |

***Note***
*Film, screen, etc. data selected are not directly stored in the generator.*
*It is recommended that they be entered in the table ”Data sets of chambers” 2Z-4 at the end of this section.*

- RESET the generator.

Color and sensitivity class of the screen/film combination are displayed on the desk, e.g.: “B400”.
Other screen/film combinations (data set 1 ... 5) for the chamber can be selected by the ± buttons.


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#### 8.3.2.2. Manual DRC processing

The current data set of the screen/film combination is displayed.

| | |
|---|---|
| * Abbreviation: | Abbreviation for the screen/film combination.<br>Example: B400 = blue, speedclass 400. |
| Dose Request Chamber: | Sensitivity of the measuring chamber type in [µGy/V]. |
| * Dose of FSC: | Switch-OFF dose of the screen/film combination in [µGy].<br>Linear ratio with respect to the film density. |
| kV70-Char. U_0 ... 9: | Checkpoints for kV-dependent density correction. |
| kV70-Char. Drel_0 ... 9: | Relative correction value for the dose. |
| RLF t_0 ... 9: | Checkpoints for time-dependent density correction.<br>(RLF = **R**eciprocity **L**aw **F**ailure). |
| RLF Drel_0 ... 9: | Relative correction value for the dose. |

* = Only these fields may be changed according to the system requirements.
All other fields must not be changed.

- If required, change the data and the abbreviation name.
  Usually no value except the basic density ”Dose of FSC” must be changed (see next page).
- Transmit the data set with **<F2>**.
- RESET the generator.

The **SAVE <F3>** and **LOAD <F4>** functions of ***XRGSCOPE*** permit straightforward copying of the measuring chamber programmings.


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### 8.3.2.3. Density correction for AEC technique (option)

**Basic density per screen/film combination:**

A hardware key is required at the PC for direct access to the switch-OFF dose.

- Make a test exposure for each screen/film combination.
  To do so, set the density correction = 0.
- Determine the density of the test exposures.
- Select menu:
  PROGRAM/ DOSE RATE CONTROL/ AMPLIMAT/ CHAMBER 1 + 2/ **DATA SET 1 ... 5**
- Select manual DRC programming by pushing the **<ESC>** key.
- Correct the switch-OFF dose = “Dose of FSC” according to formular below:

$$\text{New switch-OFF dose} = \frac{\text{Desired density}}{\text{Measured density}} \times \text{Old switch-OFF dose}$$

- Transmit the data set by pushing the **<F2>** key.
- Repeat the procedure for each screen/film combination at each chamber.
- RESET the generator.

The switch-OFF dose can be set on the PC even without a hardware key.
To do so, call up the automatic DRC programming, repeat all the selections and change the correction factor for switch-OFF dose accordingly. Each time this programming is called up all the selections must be repeated.


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### 8.3.3. Image intensifier (II)

- II lead time
- Density voltage correction: Default = 1V
- Dynamic factors

### 8.3.4. Fault exposure detection

Fault exposure detection is switched ON as a default for AEC and TDC. If in the initial phase of an exposure too little dose is measured, the exposure is aborted to protect the patient.

- Time of control measurement: 10% of backup time, min. 250ms at TDC
- Dose minimum: 4% of set density voltage at AEC, 4 ... 10% at TDC
- Backup time AEC: Calculated time from 9.5 times mAs of the respective 2-factor technique, max. 4s
- Backup time TDC: Exposure time set 0.3 ... 6s

This additional precaution can be switched OFF for both techniques individually in the menu:
PROGRAM/ DOSE RATE CONTROL/ FAULT EXPOSURE DETECTION/ **AEC OR TDC**

For details see section 4 FAULT FINDING, chapter “Optimus AEC switch-OFF philosophy”.

This monitoring does not take effect in the following cases, irrespective of programming:

- Using screen/film combinations with high speed in AEC technique.
- Exposure time in TDC technique is shorter than 1s.

### 8.3.5. Continuous fluoroscopy

Factors for continuous fluoroscopy can be modified:
(see also section 4 FAULT FINDING, ”Explanation of programming”)

- scantime TV [ms] : = 20.00ms (default) for scantime of the TV system ≤ 20ms (50Hz and 60Hz)
  = Scantime of the TV system for scantime > 20ms
- scantime TV valid : = YES default
  = NO no function yet
- P_max_EDL [W] : = 250W (default) (EDL = **E**ntrance **D**ose **L**imiter)
  (range = 0 ... 9000W) The maximum output of the tube during continuous fluoroscopy and with the SID signal prevailing is limited to the programmed wattage.

  *Function not applicable for DuoDiagnost.*
- TV_pos_limit [V] : = 6.8V (default) Adjustment necessary if the fluoroscopic image does not come up properly.
  (range = +3 ... +7.5V) See section 6 ADJUSTMENTS.
- TV_neg_limit [V] : = -6.8V (default)
  (range = -7.5 ... -3V)


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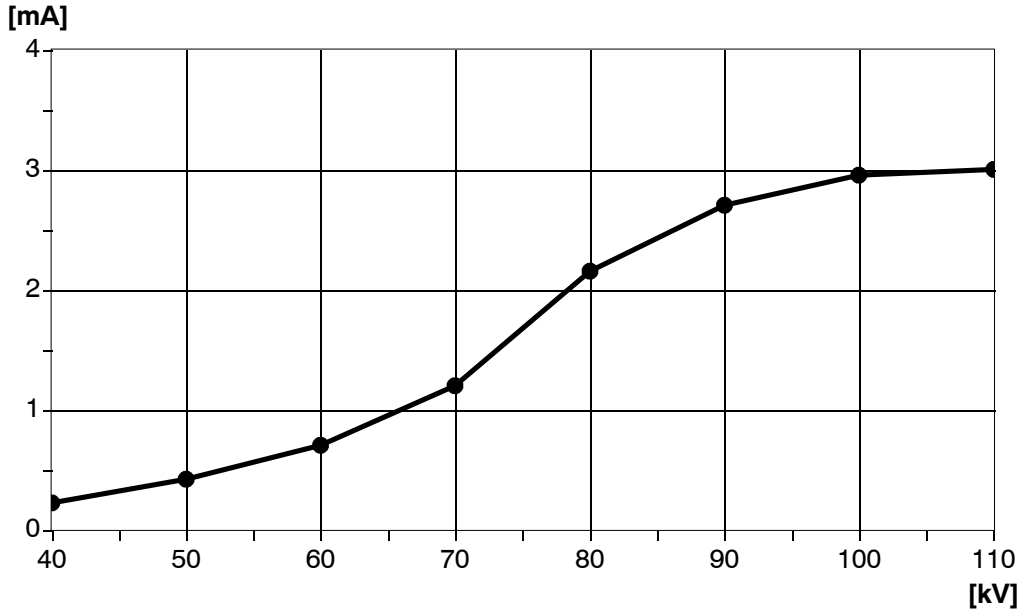
| kV | mA |
|---|---|
| 40 | 0.22 |
| 50 | 0.42 |
| 60 | 0.70 |
| 70 | 1.20 |
| 80 | 2.15 |
| 90 | 2.70 |
| 100 | 2.95 |
| 110 | 3.00 |




**kV/mA - curve: Fluoroscopy Optimus C**



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## 8.4. Application limits

### 8.4.1. X-mode limits

Using the menu:
PROGRAM/ APPLICATION LIMITS/ **X-MODE LIMITS**

Limit values can be defined for all available techniques. Some values look as if they are out of limit which they are indeed, but there are additional basic limit values programmed in the generator firmware. These are exposure technique dependent.

As an example the field of the ”Falling Load” technique:

| | |
|---|---|
| X-ray Mode: | AEC falling load kV |
| Min. Time Limit [ms]: | [1.00] |
| Max. Time Limit [ms]: | [60000.00] |
| Min. Current Time Product Limit [mAs]: | [0.001] |
| Max. Current Time Product Limit [mAs]: | [580.000] |

Min. Time Limit [ms]: Is always 1ms for all non-AEC (Automatic Exposure Control) techniques.
Exposures with AEC might be switched shorter than 1ms.

Max. Time Limit [ms]: Basic limits are technique dependent and can not be changed or increased:

| | | |
|---|---|---|
| AEC falling load | kV | 4000ms |
| AEC fixed current | kV-mA | 4000ms |
| TDC (Tomo Density Control) | | 6000ms |
| free techniques | kV-mA-ms | 16000ms |
| | kV-mAs | 16000ms |
| | kV-mAs-ms | 16000ms |

Min. Current Time Product Limit [mAs]: The smallest mAs - product is 0.5mAs.
AEC exposures with less than 0.5mAs are possible.

Max. Current Time Product Limit [mAs]: The default mAs - product is 580mAs for all AEC-techniques.
850mAs is the absolute limit the generator terminates.

**Note**
*Local limits have to be taken into consideration.*

### 8.4.2. Thoravison limits

*Function not applicable for DuoDiagnost.*

### 8.4.3. Overload-dependent limits

- max. current for continuous fluro [mA]: Range = 3 ... 30mA
- max current during overload for continuous fluro [mA]: Range = 1 ... 3mA


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## 8.5. Area exposure product calculation (option)

*Function not applicable for DuoDiagnost.*

## 8.6. Acceptance test

- Execute the acceptance test.
  See section 7: ACCEPTANCE
- Observe all applicable national regulations.

**For U.S.A applications check the H.H.S requirements!**

After completition of setting-to-work, the system must be tested for H.H.S. compliance according the P.M.S.I. comprehensive compliance testing workbook: Numeric code 4535 800 2035x.

## 8.7. Backup of all configuration data

A hardware key is required for the PC.

To save the configuration data use the CONFIGURATION BACKUP disk supplied.

- Save the complete SW programming of the generator using the menu
  ACCEPT/ BACKUP/ **CU Complete**
  on the floppy disk:
  - Default file name: cubackup.tdl
  - Recommended file name: s/n of the generator, e.g. 026012.tdl
  - File size: approx. 600kB ... 700kB
  - Transfer time: approx. 15min (Restore time: approx. 0.25h ... 1h)

- Recommendation:

  In addition, save the programmings for screen/film combinations using the menu
  PROGRAM/ DOSE RATE CONTROL/ AMPLIMAT/ CHAMBER 1 + 2/ **DATA SET 1...5**
  (manual processing) and with the SAVE function **<F3>** key on floppy disk:

  Recommended file name: drc##.tdl ## = Chamber and Data Set Number

- Provide the floppy disk with the serial number of the generator.
- Keep the floppy disk in the service documentation.


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## 9. Labels

- Check the labelling according to the respective generator type.

See drawing 2Z–10 “Labelling”.

All lables become visible by swiveling out the label bracket simply by hand and without any tool. The bracket is located at the top left corner of the front side of the cabinet, visibly marked by an ”i” (for information) and text ”Certified Component Labels Here”. If the label bracket is swiveled 90 degrees to the right the following labels appear at its bottom side:

- X-ray control:
  - type designation
  - serial No. 6 digits
  - name and address of manufacturer
  - DHHS certification statement (if necessary)
  - date of manufacture
- X-ray H.V. generator:
  - type designation
  - serial No. 7 digits
  - name and address of manufacturer
  - DHHS certification statement (if necessary)
  - date of manufacture
- Technical data label with UL / CSA classification (if necessary).

## 10. Final installation work

- Mount the side panels of the generator cabinet.
- Take care that all cables inside the wall junction box are routed in **closed** loops without any kinks.
  Push the generator cabinet against the wall.

**Warning!**

**Block the two front wheels of the cabinet with the locking screws to guarantee that unauthorized persons cannot accidentally touch parts of the generator which might be dangerous.**

- Level the cabinet with the locking screws.
- Mount the front cover of the generator.


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| | | Chamber 1 | Chamber 2 | Chamber 3 | Chamber 4 | Chamber 5 |
|---|---|---|---|---|---|---|
| **Data Set 1** | Film: | ..... | ..... | *Chambers 3; 4; 5 not applicable for DuoDiagnost.* | | |
| | Screen: | ..... | ..... | | | |
| | Chamber: | ..... | ..... | | | |
| | Cassette: | ..... | ..... | | | |
| | Sys.corr.: | ..... | ..... | | | |
| | Dose of FSC: | ..... | ..... | | | |
| **Data Set 2** | Film: | ..... | ..... | | | |
| | Screen: | ..... | ..... | | | |
| | Chamber: | ..... | ..... | | | |
| | Cassette: | ..... | ..... | | | |
| | Sys.corr.: | ..... | ..... | | | |
| | Dose of FSC: | ..... | ..... | | | |
| **Data Set 3** | Film: | ..... | ..... | | | |
| | Screen: | ..... | ..... | | | |
| | Chamber: | ..... | ..... | | | |
| | Cassette: | ..... | ..... | | | |
| | Sys.corr.: | ..... | ..... | | | |
| | Dose of FSC: | ..... | ..... | | | |
| **Data Set 4** | Film: | ..... | ..... | | | |
| | Screen: | ..... | ..... | | | |
| | Chamber: | ..... | ..... | | | |
| | Cassette: | ..... | ..... | | | |
| | Sys.corr.: | ..... | ..... | | | |
| | Dose of FSC: | ..... | ..... | | | |
| **Data Set 5** | Film: | ..... | ..... | | | |
| | Screen: | ..... | ..... | | | |
| | Chamber: | ..... | ..... | | | |
| | Cassette: | ..... | ..... | | | |
| | Sys.corr.: | ..... | ..... | | | |
| | Dose of FSC: | ..... | ..... | | | |

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Data sets of chambers



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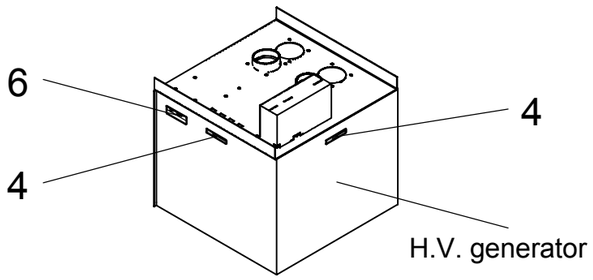


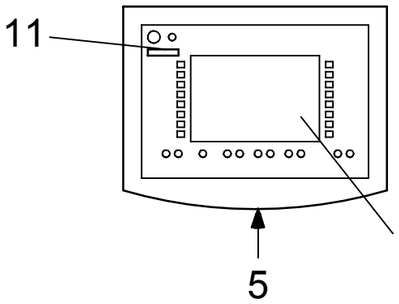


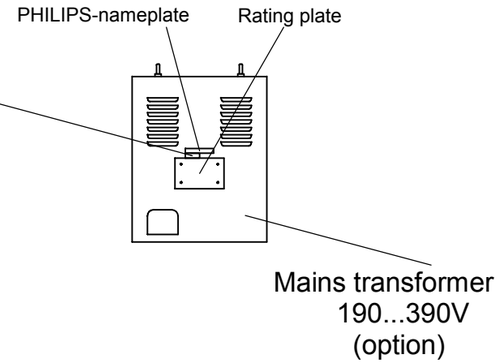


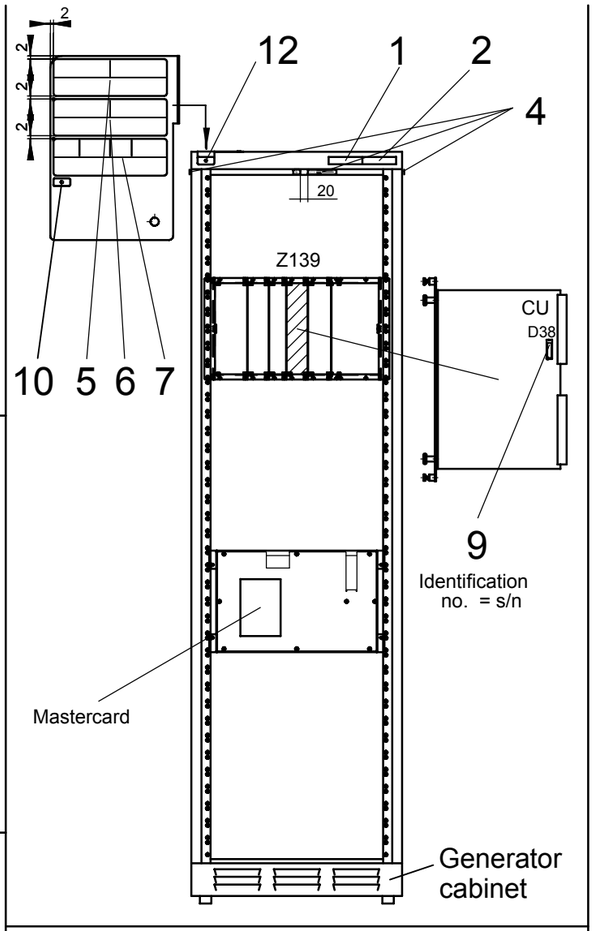


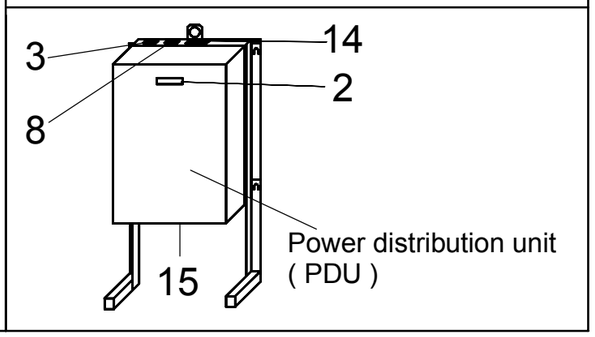


1 OPTIMUS 50

1 OPTIMUS 65

1 OPTIMUS 80

2 PHILIPS
MADE IN GERMANY

3
Philips Medical Systems
DMC GmbH
Röntgenstrasse 24
D-22335 Hamburg / Germany

4 CAUTION
HAZARD FOR LIVE AND /OR MOVING PARTS.
ATTENTION WHEN SERVICING ENERGIZED EQUIPMENT.
OBSERVE THE SERVICE-MANUAL.

7 50 kW

| | | | |
|---|---|---|---|
| 50 kW | 3~50/60Hz<br>400V<br>480V | 10A<br>8A | 145A<br>120A |

- X-RAY EQUIPMENT -
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WITH RESPECT TO ELECTRICAL FIRE,
SHOCK AND MECHANICAL HAZARDS ONLY. 641B
C UL US — UL CSA

7 65 kW

| | | | |
|---|---|---|---|
| 65kW | 3~50/60Hz<br>400V<br>480V | 10A<br>8A | 190A<br>160A |

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C UL US — UL CSA

7 80 kW

| | | | |
|---|---|---|---|
| 80kW | 3~50/60Hz<br>400V<br>480V | 10A<br>8A | 230A<br>190A |

- X-RAY EQUIPMENT -
CLASSIFIED BY UNDERWRITERS LABORATORIES INC.©
WITH RESPECT TO ELECTRICAL FIRE,
SHOCK AND MECHANICAL HAZARDS ONLY. 641B
C UL US — UL CSA

5

| | |
|---|---|
| – X-RAY CONTROL –<br>type 9890 000 0200x<br>s/n xx xxxx<br>OPTIMUS 50/65/80 | Philips Medical Systems<br>DMC GmbH<br>Röntgenstr. 24<br>D-22335 Hamburg / Germany |

CERTIFICATION This product complies with the Performance Standard under the Radiation Control for Health and Safety Act of 1968, applicable at date of manufacture.
Manufactured: MONAT, JAHR

6

| | |
|---|---|
| – X-RAY HV GENERATOR –<br>type 9890 000 xxxxx<br>s/n xx xxxx<br>OPTIMUS | Philips Medical Systems<br>DMC GmbH<br>Röntgenstr. 24<br>D-22335 Hamburg / Germany |

CERTIFICATION This product complies with the Performance Standard under the Radiation Control for Health and Safety Act of 1968, applicable at date of manufacture.
Manufactured: MONAT, JAHR

13

| | |
|---|---|
| – X-RAY CONTROL –<br>type 9890 000 xxxxx<br>s/n xx xxxx<br>OPTIMUS | Philips Medical Systems<br>DMC GmbH<br>Röntgenstr. 24<br>D-22335 Hamburg / Germany |

CERTIFICATION This product complies with the Performance Standard under the Radiation Control for Health and Safety Act of 1968, applicable at date of manufacture.
Manufactured: MONAT, JAHR

8
type Produktname
s/n Fabr. Nr.
code Code Nr.

9 SN.

10 CE 0123

11 WARNING:
THIS X-RAY UNIT MAY BE DANGEROUS TO PATIENT AND OPERATOR UNLESS SAFE EXPOSURE FACTORS AND OPERATING INSTRUCTIONS ARE OBSERVED.

12 Certified Component Labels Here

14

| | | | |
|---|---|---|---|
| | 3~50/60 Hz<br>400V<br>480V | | |
| | 11A<br>9A | | |

c UL us

15 4512 104 7073.

A3/A3 02-06-18 Schr.

Labelling


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# FAULT FINDING

## TEXT


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## DRAWINGS


| | |
|---|---|
| Central rack, service aid | 3Z-1 |




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# 1. Tools

- Service engineer mechanical tool kit
- mAs meter
- Multimeter
- Digital oscilloscope with 2-beam memory
- PC incl. 3.5” FDD, HW-dongle, serial interface cable, free RAM ≥ 590kB
- Service software ”XRGSCOPE” Version 2.2 or higher
- Recommended PLCC extraction tool (AMP 822154-1) 2422 487 89772

# 2. Notes

**Warning!**

**After the generator has been switched OFF, hazardous voltages are still applied to the D.C. intermediate circuits of the converter, the rotor control and the mA control.**

**These voltages are usually discharged within 2 minutes to values which are no longer dangerous**.

**For that reason always wait for a minimum of 2 minutes before starting any electrical work always after the generator has been switched OFF.**

**Note**

*Permanently interested in quality improvement of PMS products we depend on information from the field. Therefore please send us the current generator logfile information:*

**Please download the generator errorlog logfile in zipped format as described in chapter 4.4 “Saving data on disk and restoring data”.**

The filename must express the generator release and generator serial number.
E. g. “12020514.tdl” for Rel. “1.2” and serial number “020514”.

Send this file containing the serial number of the generator and customer data attached to an E-Mail to:

Carsten Mais
Service Innovation Generators
PMS DMC Hamburg

**E-Mail: Carsten.Mais@philips.com**

*Appreciate your help and many thanks in advance!*



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# 3. Strategy

There are 3 categories of errors:

1. The generator cannot be switched ON at all or only for a short time.
   See ⇒ 5. ”Initialization phase of the generator”
   ⇒ 6.1. ”Switch ON not possible”

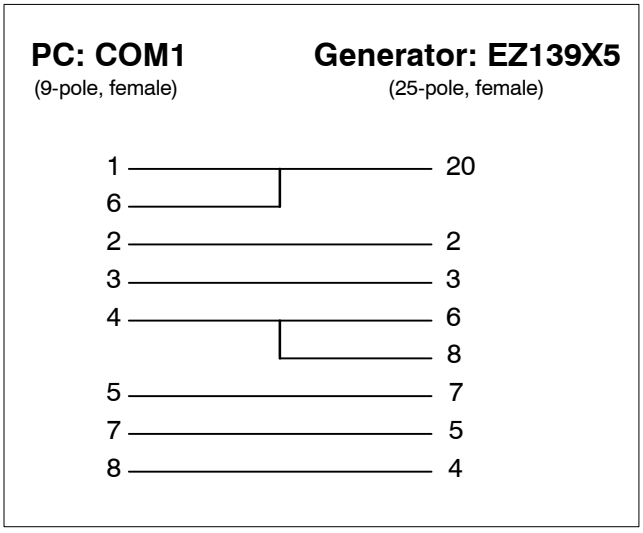
2. The generator can be switched ON but no error numbers are displayed on the operating desk.
   For fault finding use the service PC.
   See ⇒ 4.1. ”Connecting the service PC”
   ⇒ 5. ”Initialization phase of the generator”
   ⇒ 7. ”Error numbers”

3. Error messages are displayed on the desk.
   For fault finding use the service PC.
   See ⇒ 4.1. “Connecting the service PC”
   ⇒ 7. “Error numbers“

# 4. Service-PC

## 4.1. Connection

- Switch the generator ON.
- Provide the service PC with the hardware key and switch it ON.
  The hardware key provides access to special program settings and to menu ***”Faultfind”.***
  Standard programming is possible without a hardware key.
- Connect the PC to X5 on EZ139 CENTRAL UNIT CU via a serial data cable:
  (A 5m long data cable can be ordered via 12NC: 4512 130 5693x)





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## 4.2. Operation

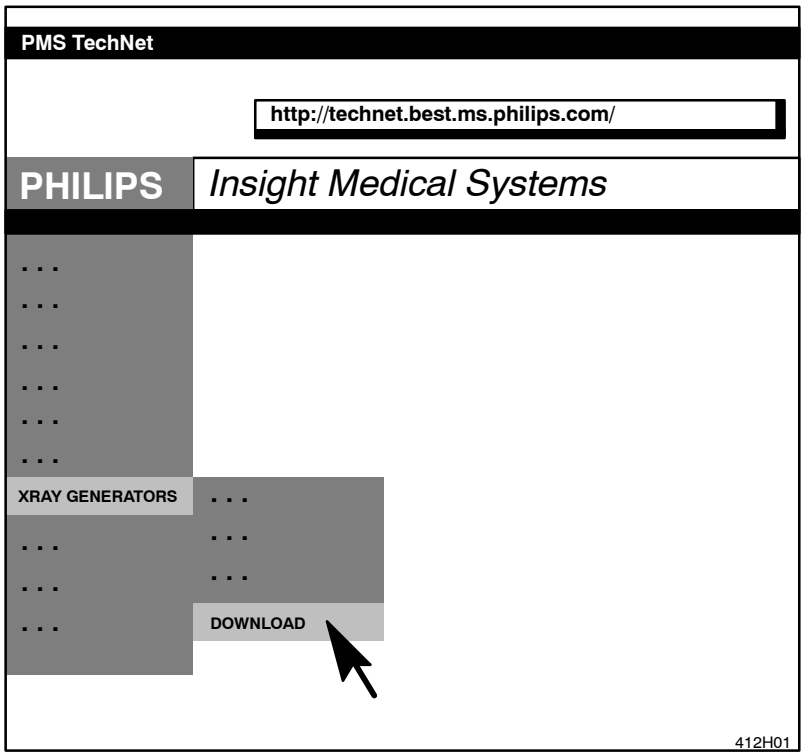
For installation of generator firmware and newest service tools see ”REPLACEMENT” chapter ”Exchange of firmware ...”.

- Call the program with **<xrgscope>** or with **<xrgscope lcd>** for PCs with LCD screen.
- Enter your password.

  The following menu line appears:

| *File* | *OPTIMUS C* | *Select Unit* | *Options* | *Help* |
|---|---|---|---|---|

Current data files, for instance, for online help, tube types, APR programming are available in the PHILIPS-Intranet. Use path: ***http://technet.best.ms.philips.com/*** and pull down menu as shown below.



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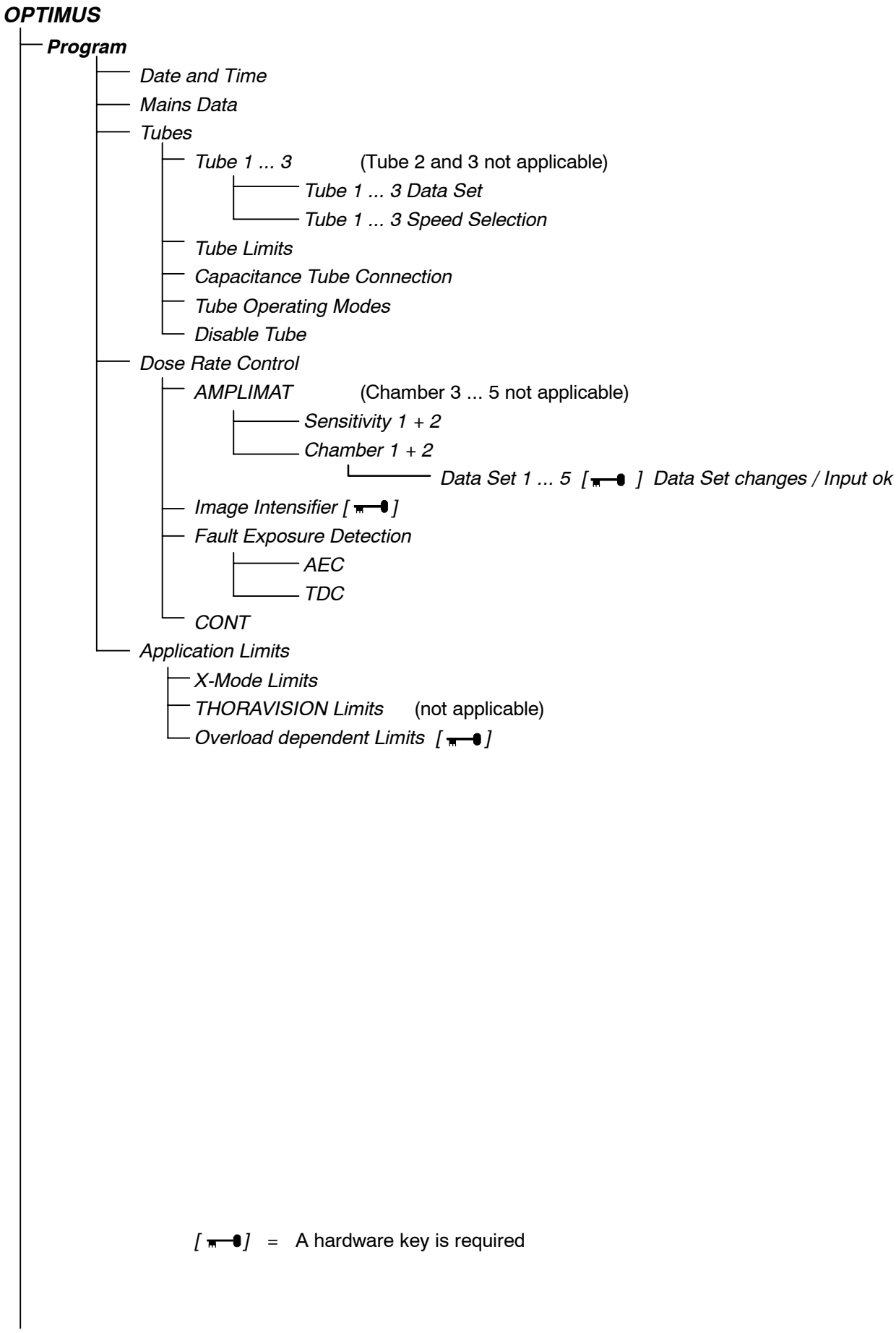
## 4.3. Menu structure





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- ***Adjust***
  - *Tube Adaptation*
  - *CAN Auto Configuration*
  - *Area Exposure Product* (not applicable)
    - *Specific Yield of Tubes*
      - *Specific Yield of Tubes 1 ... 3*
    - *Add Filter Correction Tables*
      - *2 mm Al*
      - *1 mm Al + 0.1 mm CU*
      - *1 mm Al + 0.2 mm CU*
    - *Wedge Filter Correction Table*
      - *Wedge 1*
      - *Wedge 2*
      - *Finger Wedge*
  - *Dose Rate Control [ ]*
    - *TDC AMPLIMAT* (Do not change the values without order from DMC Hamburg!)
    - *Amplification Gain*
      - *TDC*
      - *CONT*
    - *CONT kV mA manual*
  - *Boost Adaptation [ ]*

- ***Accept***
  - *Backup [ ]*
    - *CU Complete*
  - *Restore [ ]*
    - *CU Complete*
  - *Inspect*
    - *Tube 1 Statistic*
      - *Show Tube Statistic*
      - *Reset Tube Statistic [ ]*
    - *Tube 2 ... 3 Statistic* (Tube 2 and 3 not applicable)
      - *Show Tube Statistic*
      - *Reset Tube Statistic [ ]*
    - *Generator Statistic*
    - *Type of Tube 1*
    - *Type of Tube 2 ... 3* (Tube 2 and 3 not applicable)



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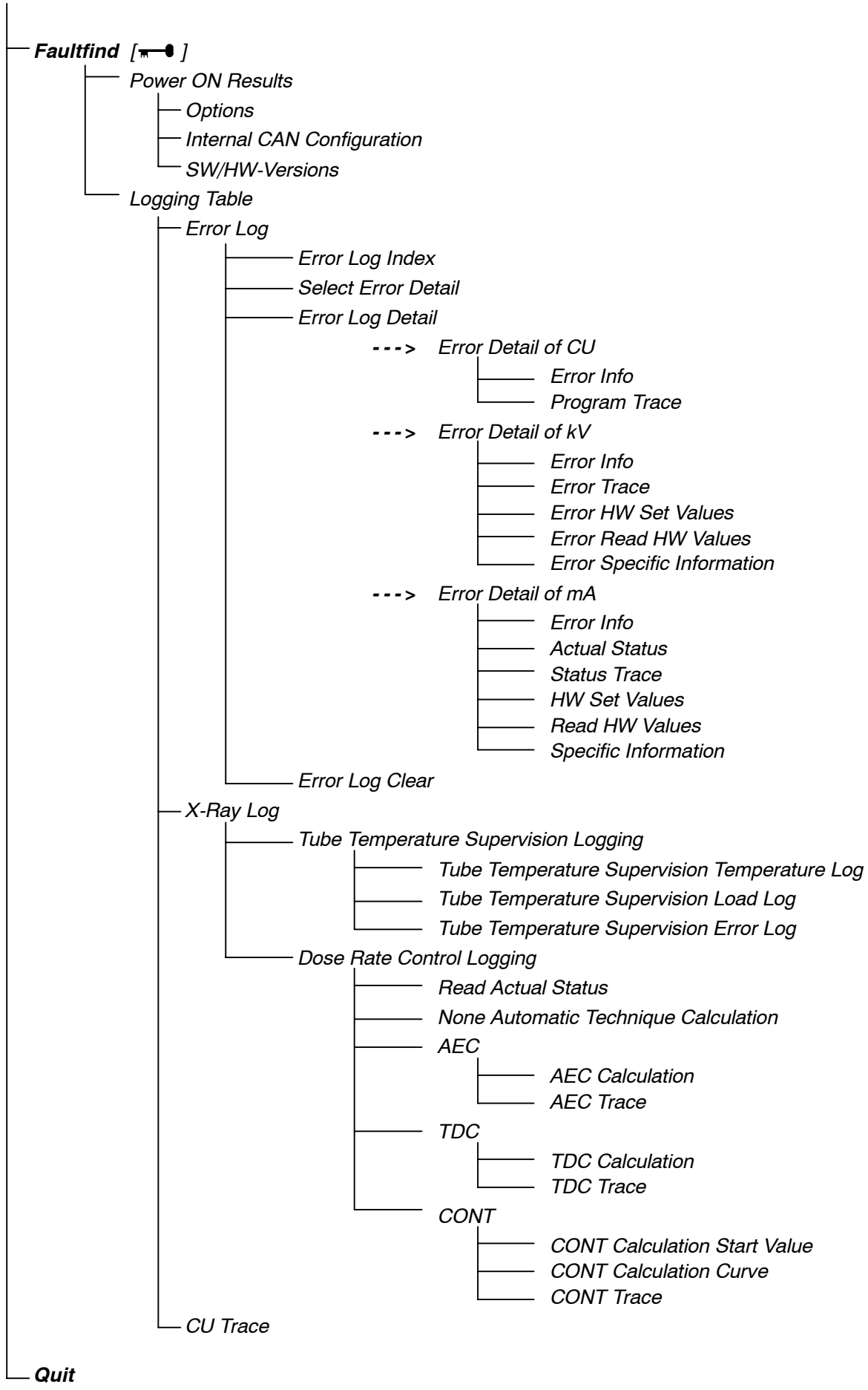



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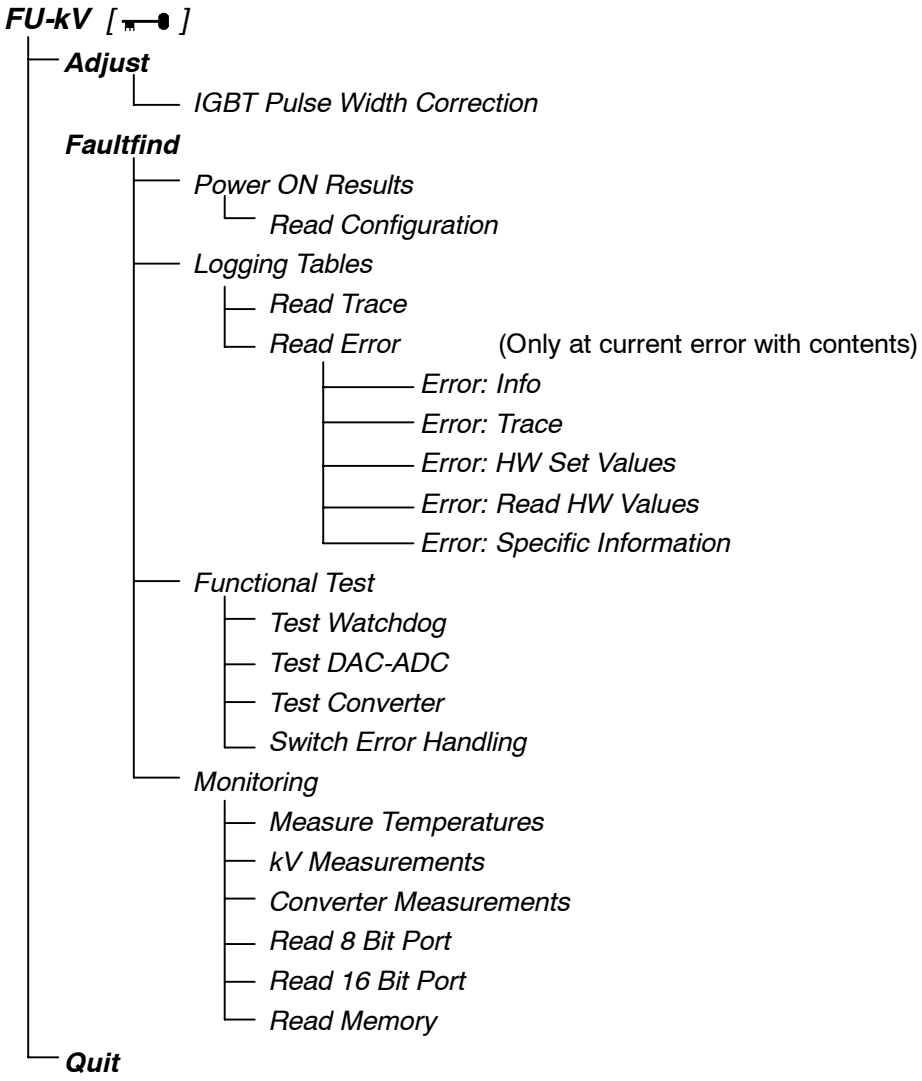




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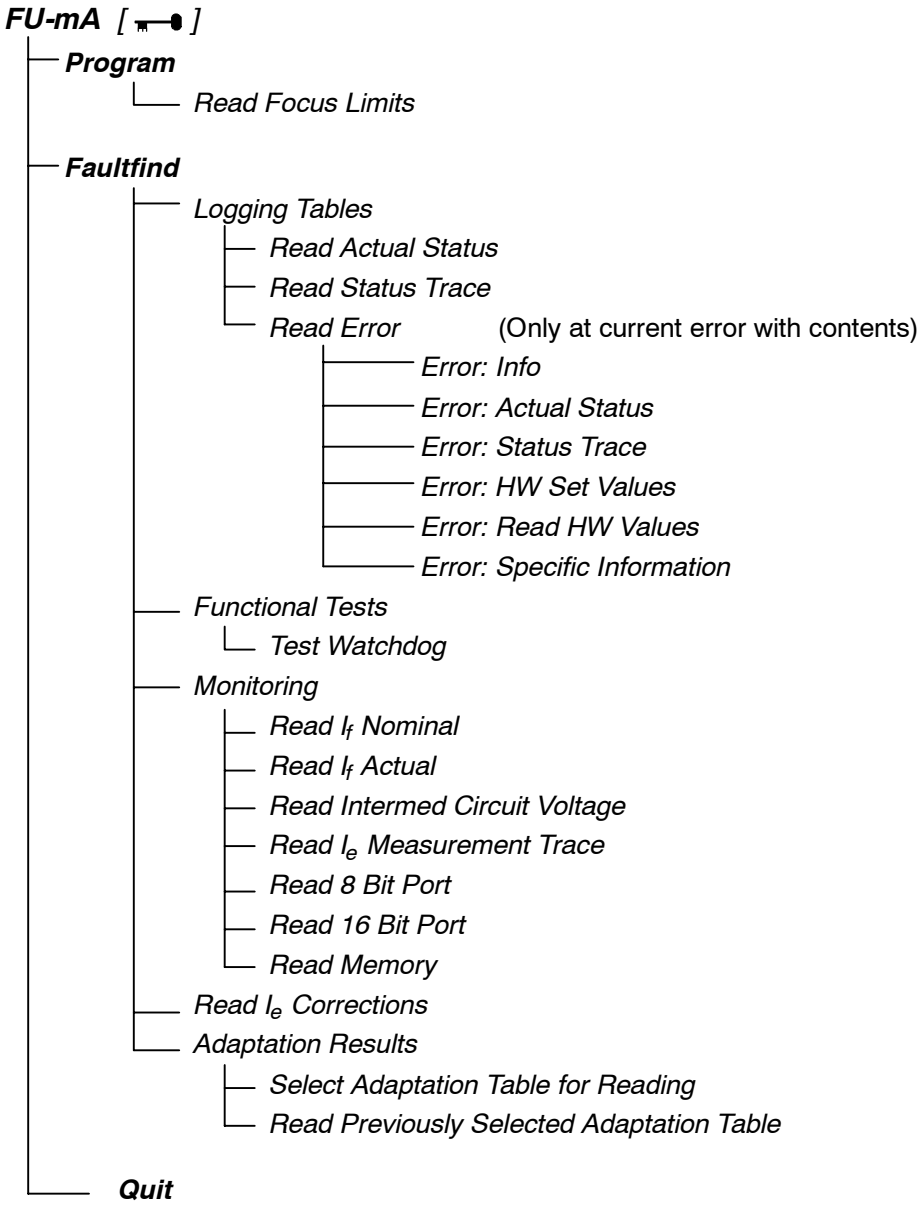



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## 4.4. Saving data on disk and restoring data

All configuration data and logging tables are stored in battery-buffered CMOS areas of the CU board.

Therefore, these data have to be saved on disk as a backup.

In case data get lost they can easily be restored in the CMOS areas after the error source has been eliminated.

**Note**
*In case of mailing CU complete download files or any other xxx.tdl files use a zipped file format.*
*These files are ASCII files which might be destroyed while being mailed.*

### 4.4.1. Saving of data

- Select menu:
  ACCEPT/ BACKUP/ **CU COMPLETE**
- Store the data on floppy disk ”Generator configuration data“ found in the service documentation:

| | |
|---|---|
| Default file name: | cubackup.tdl |
| Recommended file name: | s/n of the generator, e.g. 016012.tdl |
| File size: | approx. 500–700kB |
| Transfer time: | approx. 8min. |

- Recommendation:

  Additionally save the programmings for the film/screen combinations via the menu:
  PROGRAM/ DOSE RATE CONTROL/ AMPLIMAT/ CHAMBER 1 +2/ **DATA SET 1 ... 5** (manual processing)

  Store them with the SAVE function <F3>-key on floppy disk.

  Recommended file name: drc##.tdl ## = chamber and data set number

### 4.4.2. Restoring of data

- Select menu:
  ACCEPT/ RESTORE/ **CU COMPLETE**
- Restore the data from floppy disk.
  Transfer time approx. 15min ... 50min.
- Reset the generator.
- Program date and time.

Most of the programmings and logging tables can also be stored via the SAVE function <F3>-key of XRGSCOPE. Some programmings can be restored via the LOAD-function <F4>-key.

- For service use, only keep the latest version of the backup.

**Note**
*Never use a complete backup for a different generator, only if the hardware, firmware and option configuration are identical.*


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# 5. Initialization phase of the generator

**Start-up sequence**

Switch ON of the generator.

|
V

Pulling-up of ENK2.

|
V

Selftest of ...

| ... central unit EZ139

| ... kV control EZ130 ---> voltage E is measured in the D.C. intermediate circuit

| ... mA control EZ119

| ... basic interface EZ150

| ... rotor control EY

|

| *Indicating device: The red status LED of the associated printed-circuit board or assembly is illuminated.*

|
V

After successful selftest the status LEDs blink.

|
V

The central unit establishes connection to each functional unit via the CAN bus.

|

| *Indicating device: The red status LED of the associated printed-circuit board or assembly grows dark.*

|
V

ENK1 is switched ON.

|
V

The generator is internally ready.

|
V

The external ready circuits are checked ---> unit ready, door contact closed, thermal contact of the tube
| closed, tube not overloaded

|
V

The green READY lamp in the operating desk is illuminated.===> **The generator is in the READY state.**


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# 6. Switch ON problems

## 6.1. Switch ON not possible

See drawings: Z1-2.x

Z2-2.x.y

H1 on PCB EN100 is **not** illuminated

Error sources:
- ENF1 was released.
  For fault finding look in the error buffer.
- ENF1 is not switched ON.
- Mains voltage, especially phase L3, is not present.
- ENF2 was released.
  Check: Low-voltage supply
  Filament circuit
  Tube extension
  Rotor control
  External current consumers
- ENF2 is not switched ON.
- PCB EN100 or its connections are not okay.

H1 on PCB EN100 is illuminated

Error sources:
- The emergency-OFF circuit is open.
- The operating desk is not connected.

## 6.2. No start up

Error sources:
- EN100 V1 is defective.
  The generator receives a continuous reset via signalbus: reset sw/.
  All red LEDs of the generator are illuminated.
  Also see Z1-2.1.
- No boot PROM present: EZ139 D3 (see 5Z-1).
- Flash PROMs EZ139 D4/D5 not correctly loaded.



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# 7. Error numbers

## 7.1. Error classification

**Errors:**

- Errors are indicated by 4 digits.

- The first two digits indicate the **F**unctional **U**nit FU reporting the error.
  Example:
  00xx = CU-functional unit is concerned
  02xx = kV-functional unit is concerned
  03xx = mA-functional unit is concerned

- The last two digits indicate the error symptom.

**Displayed errors (ERROR and FATAL ERROR):**

- These errors are indicated on the display of the operating desk for the customer.
  Not all fatal errors come up on desk, use PC.

- The customer must call the service.
  The customer can inform the service about the respective error number and the service can order the spare parts needed at an early stage of the maintenance procedure.

**Not displayed errors (WARNING):**

- These errors are not relevant for the customer.

- In case an error of this category occurs frequently within a certain period of time, a displayed error can be generated.

**Note**
*No WARNINGs, but only ERRORs are displayed on the COCKPIT control desk.*

## 7.2. Error list

Sources of error codes indicated in the first two digits decimally (hexadecimally):

| Error code dec (hex) | FU (Function Unit) | Description |
|---|---|---|
| 00xx | CU | - central unit EZ139 |
| 01xx | FU_DRC | - dose rate control, control physically located on CU EZ139<br>- parts of basic interface FU_CIE EZ150 also involved (Amplimat)<br>- FU_DRC also handles fluoro kV control EZ130 |
| 02xx | FU_kV | - kV control EZ130 |
| 03xx | FU_mA_a | - 1st mA control EZ119<br>- handles 2 filaments |
| 07xx | FU_CIE | - central interface extension EZ150 basic interface |
| 10xx (0Axx) | FU_RC_a | - 1st rotor control high speed EY100 |


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Error classes: **F**ATAL ERROR, **E**RROR, **W**ARNING

1. Errors as they occur in the error trace, XRGSCOPE and on the COCKPIT control desk, sorted by alphanumerical code.

| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 00B0 | 6106648 | ERROR | CPU: Error in application data service interface | CU |
| 00B9 | 6106657 | ERROR | AD: Message from unknown function unit (FU) | CU |
| 00BP | 6106680 | ERROR | AD: Unknown message from system controller | CU |
| 00BZ | | WARNING | AD: Select mode of an unused buffer | CU |
| 00CB | | WARNING | CONF: Received IIM #1#2H unknown | CU |
| 00CC | | WARNING | CAN: Frame-repeat-counter overflow (IIM #1#2H) | CU |
| 00CD | | WARNING | CAN: FU #1H not addressable | CU |
| 00CE | | WARNING | CAN: rx-signal conflict (FU #1H) | CU |
| 00CF | | WARNING | CAN: No RTR from FU #1H | CU |
| 00CG | | WARNING | CPU: Domain tx response Mailbox type wrong | CU |
| 00CH | | WARNING | CPU: Invalid tbdor-Parameter FU_type | CU |
| 00CJ | | WARNING | CAN: Auto configuration successful (#1H) | CU |
| 00CK | | WARNING | CAN: Auto configuration without success (#1H) | CU |
| 00CL | | WARNING | CAN: FU #1H not addressable | CU |
| 00CM | | WARNING | CAN: FU #1H sent event and did not answer RTR | CU |
| 00CP | | WARNING | CAN: Max FU count exceeded | CU |
| 00CX | | WARNING | CAN: Last-only-repeat-counter overflow (IIM #1#2H) | CU |
| 00DA | 6106865 | ERROR WARNING | No CPU-Access to CAN-chip | CU |
| 00DD | | WARNING | CAN-chip DPRAM check failed | CU |
| 00DE | 6106869 | ERROR WARNING | Unexpected CAN-chip int-pointer | CU |
| 00DG | | WARNING | CAN-chip error-active after passive #1H | CU |
| 00DH | | WARNING | CAN-chip state error-passive #1H | CU |
| 00DI | 6106873 | ERROR | CAN-chip state bus-OFF #1H | CU |
| 00DL | 6106876 | ERROR | Unexpected CAN-chip interrupt | CU |
| 00DM | | WARNING | CAN: Frame error (code #1H) | CU |
| 00E0 | 6106948 | ERROR | iRMX exception #2#1H occurred. | CU |
| 00FA | | WARNING | CPU: CAL(CS)-Errorcode: #2#1H | CU |
| 00FB | | WARNING | CPU: CS: Fast Domain Error | CU |
| 00G0 | | WARNING | Variable in case statement has undefined value | CU |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.



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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 00G1 | 6107149 | ERROR | Condition_code <> OK after CALL to send | CU |
| 00G2 | | WARNING | Condition_code <> OK after CALL to init | CU |
| 00I2 | | WARNING | No interrupt reason on sig-bus | CU |
| 00I3 | | WARNING | No interrupt reason on XS-bus | CU |
| 00I4 | 6107352 | ERROR | One FU has a WD-error | CU |
| 00J1 | 6107449 | ERROR | DI: unknown IIM #1H | CU |
| 00J2 | 6107450 | ERROR | DI: rx LWDR param out of range FS= #1H PID= #2H | CU |
| 00J3 | 6107451 | ERROR | DI: rx LWDR message corrupted FS= #1H PID= #2H | CU |
| 00J4 | 6107452 | ERROR | DI: Internal table lookup failed FS= #1H PID= #2H | CU |
| 00J5 | | WARNING | DI: tx LWDR param out of range FS= #1H PID= #2H | CU |
| 00J6 | 6107454 | ERROR | DI: tx LWDR param error FS= #1H PID= #2H ER= #3H | CU |
| 00J7 | 6107455 | ERROR | DI: LWDR message creation failed | CU |
| 00J8 | | WARNING | DI: Unknown X-ray mode. No run data provided | CU |
| 00J9 | | WARNING | DI: Message from suspended device ignored | CU |
| 00JA | | WARNING | DI: No interface version received, message ignored | CU |
| 00JB | 6107466 | ERROR | DI: Unknown LWDR message received FS= #1H | CU |
| 00JC | 6107467 | ERROR | DI: tx LWDR message size invalid FS= #1H | CU |
| 00L1 | 6107649 | ERROR | GC: Checksum error | CU |
| 00L2 | 6107650 | ERROR | GC: Data access error | CU |
| 00L3 | 6107651 | ERROR | GC: Limit data error | CU |
| 00L4 | 6107652 | ERROR | GC: Limits inconsistent | CU |
| 00L5 | 6107653 | ERROR | GC: Calculation error | CU |
| 00L6 | 6107654 | ERROR | GC: Function not implemented | CU |
| 00M0 | 6107748 | ERROR | Unable to initialize FU(s) #1H, #2H, #3H, #4H, #5H, #6H | CU |
| 00M1 | 6107749 | ERROR | Configuration key is missing or defective | CU |
| 00M3 | 6107751 | ERROR | No response at all from FU(s) #1H, #2H, #3H, #4H, #5H, #6H | CU |
| 00M4 | 6107752 | ERROR | Function value from SE out of range | CU |
| 00M5 | 6107753 | ERROR | Procedure index from SE out of range | CU |
| 00MA | | WARNING | Limit for allocated memory exceeded | CU |
| 00MB | | WARNING | Limit for available memory exceeded | CU |
| 00MC | | WARNING | Limit for borrowed memory exceeded | CU |
| 00MD | | WARNING | Allocated memory is increasing | CU |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.


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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 00ME | | WARNING | Available memory is decreasing | CU |
| 00MF | | WARNING | Borrowed memory is increasing | CU |
| 00MG | | WARNING | NVRAM: Main control, NV checksum error | CU |
| 00MH | 6107772 | ERROR | Job incorrectly identified | CU |
| 00PA | | WARNING | CPU: IIM/MSC number unknown | CU |
| 00PB | | WARNING | CPU: Technique mode unknown | CU |
| 00PC | | WARNING | CPU: Value limit overflow | CU |
| 00PD | 6108068 | ERROR | PC comm.: Unknown TDL proc id | CU |
| 00PE | | WARNING | NVRAM: DRC NV checksum error | CU |
| 00PF | | WARNING | CPU: Equal kV-sets from CU comes twice | CU |
| 00PG | | WARNING | CPU: kV sequence does not increase | CU |
| 00PH | | WARNING | CPU: EDL is not possible, min_mA limit | CU |
| 00PI | | WARNING | CPU: DCALC Dr_curve has only one element | CU |
| 00PJ | | WARNING | CPU: DCALC Dr_curve has strange values | CU |
| 00PK | | WARNING | CPU: Equal kV-sets from CU with equal mA | CU |
| 00PL | | WARNING | CPU: Dose digits disturbance | CU |
| 00S* | | SERVICE | PC comm.: Service access trace | CU |
| 00S? | 6108363 | ERROR | PC comm.: Unexpected error | CU |
| 00S0 | 6108348 | ERROR | PC comm.: Tube programming error | CU |
| 00SA | 6108365 | ERROR | PC comm.: Not enough space at destination segment | CU |
| 00SC | 6108367 | ERROR | PC comm.: Value too large | CU |
| 00SD | 6108368 | ERROR | PC comm.: Terminator not found | CU |
| 00SE | 6108369 | ERROR | PC comm.: Error in description | CU |
| 00SF | 6108370 | ERROR | PC comm.: Item type unknown | CU |
| 00SG | 6108371 | ERROR | PC comm.: Internal type unknown | CU |
| 00SH | 6108372 | ERROR | PC comm.: Value negative | CU |
| 00SJ | 6108374 | ERROR | PC comm.: Syntax wrong | CU |
| 00SK | 6108375 | ERROR | PC comm.: String too long | CU |
| 00SL | | WARNING | PC comm.: String truncated | CU |
| 00SM | | WARNING | PC comm.: TDL segment overflow | CU |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 00SN | 6108378 | ERROR | PC comm.: FU reference table full | CU |
| 00SO | 6108379 | ERROR | PC comm.: Node ID unknown | CU |
| 00SP | 6108380 | ERROR | PC comm.: FU code unknown | CU |
| 00SQ | 6108381 | ERROR | PC comm.: Syntax error in node ID | CU |
| 00SR | | WARNING | PC comm.: No node ID found | CU |
| 00SS | 6108383 | ERROR | PC comm.: Request not performed | CU |
| 00ST | 6108384 | ERROR | PC comm.: RMX error | CU |
| 00SU | | WARNING | PC comm.: Enumeration element not found | CU |
| 00SV | 6108386 | ERROR | PC comm.: Mail corrupted | CU |
| 00SW | 6108387 | ERROR | PC comm.: Procedure ID unknown | CU |
| 00SX | 6108388 | ERROR | PC comm.: FU mA incompatible | CU |
| 00SY | 6108389 | ERROR | PC comm.: FU Off request failed | CU |
| 00SZ | 6108390 | ERROR | PC comm.: Wrong response | CU |
| 00T? | 6108463 | ERROR | TTS: Unexpected error | CU |
| 00TA | 6108465 | ERROR | TTS: Received message unknown | CU |
| 00TB | 6108466 | ERROR | TTS: Tube supervision error from FU kV | CU |
| 00TC | 6108467 | ERROR | TTS: Internal TTS error | CU |
| 00TD | 6108468 | ERROR | TTS: Tube number unknown | CU |
| 00TE | 6108469 | ERROR | TTS: NVRAM checksum error | CU |
| 00TF | 6108470 | ERROR | TTS: NVRAM unavailable | CU |
| 00TG | 6108471 | ERROR | TTS: Tube overheated | CU |
| 00TH | | WARNING | TTS: Load data supply inconsistent | CU |
| 00X0 | 6108848 | ERROR | CPU: Wrong timer id | CU |
| 00X1 | 6108849 | ERROR | CPU: Wrong timer mode | CU |
| 00X2 | 6108850 | ERROR | CPU: Wrong message type | CU |
| 00X3 | | WARNING | CPU: DWORD does not fit into BYTE3 | CU |
| 00X4 | 6108852 | ERROR WARNING | Timeout of X-ray backup timer | CU |
| 00X5 | | WARNING | Timeout of X-ray rotation timer | CU |
| 00X6 | | WARNING | Timeout setting FUs, response missing | CU |
| 00X7 | | WARNING | CPU curve token is NO_TOKEN | CU |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 00XB | | WARNING | NVRAM tube data rotation invalid | CU |
| 00XC | | WARNING | NVRAM watch dog invalid | CU |
| 00XD | | WARNING | NVRAM confi table invalid | CU |
| 00XE | | WARNING | NVRAM test data invalid | CU |
| 00XF | | WARNING | NVRAM RoCo data invalid | CU |
| 00XI | 6108873 | ERROR | Init with FU-RoCo not OK | CU |
| 00XJ | 6108874 | ERROR WARNING | Exposure time too short | CU |
| 00XK | | WARNING | CPU: FUmA refuses set data | CU |
| 00XL | | WARNING | NVRAM tube yield table invalid | CU |
| 00XM | | WARNING | NVRAM add filter corr table invalid | CU |
| 00XN | | WARNING | NVRAM wedge filter corr table invalid | CU |
| 00XO | 6108879 | ERROR | Exposure time too long | CU |
| 00XP | | WARNING | Exposure time too long | CU |
| 00XQ | | WARNING | NVRAM tube statistic data invalid | CU |
| 00XR | | WARNING | | CU |
| 00XS | | WARNING | Tube no in CU and FUkV different | CU |
| 00XT | | WARNING | Rotation in CU and FURoCo FUCIE diff. | CU |
| 00XU | 6108885 | ERROR | Transition endless loop | CU |
| 00XV | | WARNING | NVRAM HW test flags invalid | CU |
| 00XW | 6108887 | ERROR | EN_X active in startup | CU |
| 00XX | 6108888 | ERROR | RD_PR_X stays active after prep | CU |
| 02AB | | WARNING | Procedure called with wrong parameter | FU_kV |
| 02AC | 6126567 | ERROR | Wrong index for table access | FU_kV |
| 02AD | 6126568 | ERROR | Wrong do case entry | FU_kV |
| 02AE | | WARNING | Unknown IIM received | FU_kV |
| 02AF | | WARNING | IIM parameter out of range | FU_kV |
| 02CA | | WARNING | Error in CASE selector | FU_kV |
| 02CB | | WARNING | A CAN message with wrong IIM-no (no recipient defined) received | FU_kV |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.



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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 02CC | | WARNING | Multiple reception of the same CAN frame (transmitter ill) | FU_kV |
| 02CE | | WARNING | Unexpected signal value in CAN rx task | FU_kV |
| 02CF | | WARNING | CAN bus timeout while domain transmission | FU_kV |
| 02CG | | WARNING | Token of CAN response mailbox is not a mailbox token | FU_kV |
| 02CX | | WARNING | Multiple rx of the same CAN last/only frame (transmitter ill) | FU_kV |
| 02CY | | WARNING | Aborted CAN domain receive (because of timeout or wrong signal) | FU_kV |
| 02CZ | | WARNING | Unexpected CAN domain frame received (outside IIM–reception) | FU_kV |
| 02DA | | WARNING | No CPU access to the CAN controller | FU_kV |
| 02DB | | WARNING | Reset or release of the CAN controller was not acknowledged | FU_kV |
| 02DD | | WARNING | Check of the DPRAM of the CAN controller failed | FU_kV |
| 02DE | | WARNING | Unexpected interrupt pointer in the CAN controller | FU_kV |
| 02DF | | WARNING | CAN controller state undefined | FU_kV |
| 02DG | | WARNING | CAN controller state ERROR ACTIVE after ERROR PASSIVE | FU_kV |
| 02DH | | WARNING | CAN controller state ERROR PASSIVE | FU_kV |
| 02DI | | WARNING | CAN controller state BUS OFF | FU_kV |
| 02DJ | | WARNING | CAN controller state DPRAM ERROR | FU_kV |
| 02DK | | WARNING | CAN controller state DPRAM ERROR and ERROR PASSIVE | FU_kV |
| 02EA | 6126965 | ERROR | Interrupt 0: Divide by zero | FU_kV |
| 02EB | 6126966 | ERROR | Interrupt 1: Single step | FU_kV |
| 02EC | 6126967 | ERROR | Interrupt 2: NMI | FU_kV |
| 02ED | 6126968 | ERROR | Interrupt 3: Breakpoint | FU_kV |
| 02EE | 6126969 | ERROR | Interrupt 4: Overflow exception | FU_kV |
| 02EF | 6126970 | ERROR | Interrupt 5: Array bounds exception | FU_kV |
| 02EG | 6126971 | ERROR | Interrupt 6: Unused opcode | FU_kV |
| 02EH | 6126972 | ERROR | Interrupt 7: ESC opcode | FU_kV |
| 02EI | 6126973 | ERROR | CAN connection to CU lost | FU_kV |
| 02GA | | WARNING | Interpolation not possible | FU_kV |
| 02HA | | WARNING | kV nominal value out of range | FU_kV |
| 02HB | 6127266 | ERROR | kV nominal value out of range | FU_kV |
| 02HC | | WARNING | Z nominal value out of range | FU_kV |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 02HD | 6127268 | ERROR | Z nominal value out of range | FU_kV |
| 02HE | | WARNING | kV value during standby too large | FU_kV |
| 02HF | 6127270 | ERROR | kV value during standby too large | FU_kV |
| 02HG | | WARNING | kV actual value out of range | FU_kV |
| 02HH | 6127272 | ERROR | kV actual value out of range | FU_kV |
| 02HI | | WARNING | E value during standby out of range | FU_kV |
| 02HJ | 6127274 | ERROR | E value during standby out of range | FU_kV |
| 02HK | | WARNING | E value during high tension out of range | FU_kV |
| 02HL | 6127276 | ERROR | E value during high tension out of range | FU_kV |
| 02HM | | WARNING | Converter 1 temperature out of range | FU_kV |
| 02HN | 6127278 | ERROR | Converter 1 temperature out of range | FU_kV |
| 02HO | | WARNING | Converter 2 temperature out of range | FU_kV |
| 02HP | 6127280 | ERROR | Converter 2 temperature out of range | FU_kV |
| 02HQ | | WARNING | High voltage tank temperature out of range | FU_kV |
| 02HR | 6127282 | ERROR | High voltage tank temperature out of range | FU_kV |
| 02HS | | WARNING | Divider test cathode out of range | FU_kV |
| 02HT | 6127284 | ERROR | Divider test cathode out of range | FU_kV |
| 02HU | | WARNING | Divider test anode out of range | FU_kV |
| 02HV | 6127286 | ERROR | Divider test anode out of range | FU_kV |
| 02HW | | WARNING | kV asymmetrical | FU_kV |
| 02HX | 6127288 | ERROR | kV asymmetrical | FU_kV |
| 02MA | 6127765 | ERROR | State request not accepted because of grid mode | FU_kV |
| 02MB | 6127766 | ERROR | State request not accepted because of error state | FU_kV |
| 02MC | | WARNING | State requested by CU unknown | FU_kV |
| 02OA | 6127965 | ERROR | RMX error: Timeout | FU_kV |
| 02OB | 6127966 | ERROR | RMX error: Memory | FU_kV |
| 02OC | 6127967 | ERROR | RMX error: Busy | FU_kV |
| 02OE | 6127969 | ERROR | RMX error: Limit | FU_kV |
| 02OF | 6127970 | ERROR | RMX error: Context | FU_kV |
| 02OG | 6127971 | ERROR | RMX error: Exist | FU_kV |
| 02OH | 6127972 | ERROR | RMX error: State | FU_kV |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 02OI | 6127973 | ERROR | RMX error: Not configured | FU_kV |
| 02OJ | 6127974 | ERROR | RMX error: Interrupt saturation | FU_kV |
| 02OK | 6127975 | ERROR | RMX error: Interrupt overflow | FU_kV |
| 02OL | 6127976 | ERROR | RMX error: Transmission | FU_kV |
| 02OM | 6127977 | ERROR | RMX error: Divide by zero | FU_kV |
| 02ON | 6127978 | ERROR | RMX error: Overflow | FU_kV |
| 02OO | 6127979 | ERROR | RMX error: Type | FU_kV |
| 02OP | 6127980 | ERROR | RMX error: Parameter | FU_kV |
| 02OQ | 6127981 | ERROR | RMX error: Bad call | FU_kV |
| 02OR | 6127982 | ERROR | RMX error: Array bound | FU_kV |
| 02OS | 6127983 | ERROR | RMX error: NDP error | FU_kV |
| 02OT | 6127984 | ERROR | RMX error: Illegal opcode | FU_kV |
| 02OU | 6127985 | ERROR | RMX error: Emulator trap | FU_kV |
| 02OV | 6127986 | ERROR | RMX error: Interrupt table limit | FU_kV |
| 02OW | 6127987 | ERROR | RMX error: CPU xfer data limit | FU_kV |
| 02OX | 6127988 | ERROR | RMX error: Wrap around | FU_kV |
| 02OY | 6127989 | ERROR | RMX error: Check exception | FU_kV |
| 02OZ | 6127990 | ERROR | RMX error: Unknown | FU_kV |
| 02RA | | WARNING | Grid mode changeover requested during preparation | FU_kV |
| 02RB | | WARNING | Tube switch requested during preparation | FU_kV |
| 02RC | | WARNING | Requested P out of range | FU_kV |
| 02SA | | WARNING | Not enough space at the destination | FU_kV |
| 02SB | | WARNING | Base out of range | FU_kV |
| 02SC | | WARNING | PC comm..: Value too large | FU_kV |
| 02SD | | WARNING | Terminator not found | FU_kV |
| 02SE | | WARNING | PC comm.: Error in description | FU_kV |
| 02SF | | WARNING | PC comm.: Item type unknown | FU_kV |
| 02SG | | WARNING | PC comm.: Internal type unknown | FU_kV |
| 02SH | | WARNING | PC comm.: Value negative | FU_kV |
| 02SI | | WARNING | PC comm.: No space at dest. buffer | FU_kV |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 02SJ | | WARNING | PC comm.: Syntax wrong | FU_kV |
| 02SK | | WARNING | PC comm.: String too long | FU_kV |
| 02SL | | WARNING | PC comm.: String truncated | FU_kV |
| 02SO | | WARNING | PC comm.: Unknown table ID received | FU_kV |
| 02SP | | WARNING | PC comm.: Access level to low | FU_kV |
| 02SQ | | WARNING | PC comm.: Unknown action requested | FU_kV |
| 02SR | | WARNING | PC comm.: Routing or message corrupt | FU_kV |
| 02SS | | WARNING | Source buffer to small for incoming message | FU_kV |
| 02ST | | WARNING | CAN buffer to small for outgoing message | FU_kV |
| 02SU | | WARNING | PC comm.: Access. level is N_A | FU_kV |
| 02UA | 6128565 | ERROR | HW configuration identifier wrong | FU_kV |
| 02UB | | WARNING | Set up request received during preparation | FU_kV |
| 02WA | | WARNING | Wrong tube selected | FU_kV |
| 02WB | 6128766 | ERROR | Wrong tube selected | FU_kV |
| 02WC | | WARNING | EN X C signal faulty | FU_kV |
| 02WD | 6128768 | ERROR | EN X C signal faulty | FU_kV |
| 02WE | | WARNING | Wrong grid mode selected | FU_kV |
| 02WF | 6128770 | ERROR | Wrong grid mode selected | FU_kV |
| 02WG | | WARNING | Tube arcing detected | FU_kV |
| 02WH | 6128772 | ERROR | Tube arcing detected | FU_kV |
| 02WI | | WARNING | kV over voltage detected | FU_kV |
| 02WJ | 6128774 | ERROR | kV over voltage detected | FU_kV |
| 02WK | | WARNING | Measuring not stable | FU_kV |
| 02WL | 6128776 | ERROR | Tube supervision error | FU_kV |
| 02WM | 6128777 | ERROR | Tube supervision error | FU_kV |
| 03AA | | WARNING | Internal parameter error | FU_mA |
| 03AB | | WARNING | Wrong parameter from CU | FU_mA |
| 03AC | | WARNING | Ie-regulation active on two filaments | FU_mA |
| 03AI | | WARNING | Wrong IIM received | FU_mA |
| 03BA | | WARNING | Coordinates not monotonous | FU_mA |
| 03BB | | WARNING | No measurement values for adap. found | FU_mA |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 03CA | | WARNING | Error in CASE selector | FU_mA |
| 03CB | | WARNING | A CAN message with wrong IIM-no (no recipient defined) received | FU_mA |
| 03CC | | WARNING | Multiple reception of the same CAN frame (transmitter ill) | FU_mA |
| 03CE | | WARNING | Unexpected signal value in CAN rx task | FU_mA |
| 03CF | | WARNING | CAN bus timeout while domain transmission | FU_mA |
| 03CG | | WARNING | Token of CAN response mailbox is not a mailbox token | FU_mA |
| 03CX | | WARNING | Multiple rx of the same CAN last/only frame (transmitter ill) | FU_mA |
| 03CY | | WARNING | Aborted CAN domain receive (because of timeout or wrong signal) | FU_mA |
| 03CZ | | WARNING | Unexpected CAN domain frame received (outside IIM-reception) | FU_mA |
| 03DA | | WARNING | No CPU access to the CAN controller | FU_mA |
| 03DB | | WARNING | Reset or release of the CAN controller was not acknowledged | FU_mA |
| 03DD | | WARNING | Check of the DPRAM of the CAN controller failed | FU_mA |
| 03DE | | WARNING | Unexpected interrupt pointer in the CAN controller | FU_mA |
| 03DF | | WARNING | CAN controller state undefined | FU_mA |
| 03DG | | WARNING | CAN controller state ERROR ACTIVE after ERROR PASSIVE | FU_mA |
| 03DH | | WARNING | CAN controller state ERROR PASSIVE | FU_mA |
| 03DI | | WARNING | CAN controller state BUS OFF | FU_mA |
| 03DJ | | WARNING | CAN controller state DPRAM ERROR | FU_mA |
| 03DK | | WARNING | CAN controller state DPRAM ERROR and ERROR PASSIVE | FU_mA |
| 03EA | 6136965 | ERROR | CPU interrupt 0 | FU_mA |
| 03EB | 6136966 | ERROR | CPU interrupt 1 | FU_mA |
| 03ED | 6136968 | ERROR | CPU interrupt 3 | FU_mA |
| 03EE | 6136969 | ERROR | CPU interrupt 4 | FU_mA |
| 03EF | 6136970 | ERROR | CPU interrupt 5 | FU_mA |
| 03EG | 6136971 | ERROR | CPU interrupt 6 | FU_mA |
| 03EH | 6136972 | ERROR | CPU interrupt 7 | FU_mA |
| 03EI | 6136973 | ERROR | CAN is unable to send an error to CU | FU_mA |
| 03FA | | WARNING | NVRAM: Invalid checksum | FU_mA |
| 03FB | | WARNING | NVRAM: Standby filament not found | FU_mA |
| 03FC | 6137067 | ERROR | No NVRAM plugged in | FU_mA |
| 03FD | | WARNING | NVRAM empty | FU_mA |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 03GA | 6137165 | ERROR | Limit error | FU_mA |
| 03GB | | WARNING | Real math. error: Real underflow | FU_mA |
| 03GC | | WARNING | Real math. error: Real overflow | FU_mA |
| 03GD | | WARNING | Real math. error: Dword overflow | FU_mA |
| 03GE | | WARNING | Real math. error: Integer overflow | FU_mA |
| 03GF | | WARNING | Real math. error: Word overflow | FU_mA |
| 03GG | | WARNING | Singular matrix | FU_mA |
| 03HA | 6137265 | ERROR | Unknown hardware | FU_mA |
| 03HB | 6137266 | WARNING ERROR | Intermediate circuit voltage < 200V | FU_mA |
| 03HF | | WARNING | Undefined analog input channel | FU_mA |
| 03HG | | WARNING | If-actual out of tolerance | FU_mA |
| 03HH | 6137272 | ERROR | If setpoint to large | FU_mA |
| 03HI | 6137273 | ERROR | If-actual out of tolerance | FU_mA |
| 03HJ | 6137274 | ERROR | If-actual out of tolerance | FU_mA |
| 03HK | | WARNING | If-nominal out of tolerance | FU_mA |
| 03HL | 6137276 | ERROR | If-nominal out of tolerance | FU_mA |
| 03HM | 6137277 | ERROR | If-nominal out of tolerance | FU_mA |
| 03HN | 6137278 | ERROR | No retrigger received from CU | FU_mA |
| 03IA | | WARNING | Adaptation can not be completed | FU_mA |
| 03IC | | WARNING | No Ie-adaptation measurement values | FU_mA |
| 03ID | | WARNING | Ie-adaptation values not evolvable | FU_mA |
| 03KA | | WARNING | Condi.-X-Ray mode without mAs parameter | FU_mA |
| 03MA | | WARNING | Undefined status | FU_mA |
| 03MB | | WARNING | Status change not allowed | FU_mA |
| 03MC | | WARNING | FU init data not expected | FU_mA |
| 03OA | 6137965 | ERROR | RMX exception: E$TIME | FU_mA |
| 03OB | 6137966 | ERROR | RMX exception: E$MEM | FU_mA |
| 03OC | 6137967 | ERROR | RMX exception: E$BUSY | FU_mA |
| 03OD | 6137968 | ERROR | RMX exception: E$LIMIT | FU_mA |
| 03OE | 6137969 | ERROR | RMX exception: E$CONTEXT | FU_mA |
| 03OF | 6137970 | ERROR | RMX exception: E$EXIST | FU_mA |
| 03OG | 6137971 | ERROR | RMX exception: E$STATE | FU_mA |

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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 03OH | 6137972 | ERROR | RMX exception: E$NOT$CONFIGURED | FU_mA |
| 03OI | 6137973 | ERROR | RMX exception: E$INTERRUPT$SATURATION | FU_mA |
| 03OJ | 6137974 | ERROR | RMX exception: E$INTERRUPT$OVERFLOW | FU_mA |
| 03OK | 6137975 | ERROR | RMX exception: E$TRANSMISSION | FU_mA |
| 03OL | 6137976 | ERROR | RMX exception: E$ZERO$DIVIDE | FU_mA |
| 03OM | 6137977 | ERROR | RMX exception: E$OVERFLOW | FU_mA |
| 03ON | 6137978 | ERROR | RMX exception: E$TYPE | FU_mA |
| 03OO | 6137979 | ERROR | RMX exception: E$PARAM | FU_mA |
| 03OP | 6137980 | ERROR | RMX exception: E$BAD$CALL | FU_mA |
| 03OQ | 6137981 | ERROR | RMX exception: E$ARRAY$BOUND | FU_mA |
| 03OR | 6137982 | ERROR | RMX exception: E$NDP$ERROR | FU_mA |
| 03OS | 6137983 | ERROR | RMX exception: E$ILLEGAL$OPCODE | FU_mA |
| 03OT | 6137984 | ERROR | RMX exception: E$EMULATOR$TRAP | FU_mA |
| 03OU | 6137985 | ERROR | RMX exception: E$INTERRUPT$TABLE$LIMIT | FU_mA |
| 03OV | 6137986 | ERROR | RMX exception: E$CPUXFER$DATA$LIMIT | FU_mA |
| 03OW | 6137987 | ERROR | RMX exception: E$SEG$WRAP$AROUND | FU_mA |
| 03OX | 6137988 | ERROR | RMX exception: E$CHECK$EXCEPTION | FU_mA |
| 03OY | 6137989 | ERROR | Unknown RMX exception | FU_mA |
| 03PA | 6138065 | ERROR | Ie zero measured | FU_mA |
| 03PB | | WARNING | Ie out of tolerance | FU_mA |
| 03PC | 6138067 | ERROR | Ie out of tolerance | FU_mA |
| 03PD | | WARNING | Setpoint for Ie-regulation incorrect | FU_mA |
| 03PE | 6138069 | ERROR | Emergency OFF, grid not closed! | FU_mA |
| 03PF | 6138070 | ERROR | No kV discharged due to missing Ie | FU_mA |
| 03SC | | WARNING | PC comm.: Value too large | FU_mA |
| 03SE | | WARNING | PC comm.: Error in description | FU_mA |
| 03SF | | WARNING | PC comm.: Item type unknown | FU_mA |
| 03SG | | WARNING | PC comm.: Internal type unknown | FU_mA |
| 03SH | | WARNING | PC comm.: Value negative | FU_mA |
| 03SI | | WARNING | PC comm.: No space at dest. buffer | FU_mA |
| 03SJ | | WARNING | PC comm.: Syntax wrong | FU_mA |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.


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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 03SK | | WARNING | PC comm.: String too long | FU_mA |
| 03SL | | WARNING | PC comm.: String truncated | FU_mA |
| 03SO | | WARNING | PC comm.: Unknown Table ID Received | FU_mA |
| 03SP | | WARNING | PC comm.: Access Level to Low | FU_mA |
| 03SQ | | WARNING | PC comm.: Unknown Action Requested | FU_mA |
| 03SR | | WARNING | PC comm.: Routing or Message Corrupt | FU_mA |
| 03SU | | WARNING | PC comm.: Access. level is N_A | FU_mA |
| 07CA | 6176765 | ERROR | CAN: Case-selector error | FU_CIE |
| 07CB | | WARNING | CAN: Invalid CAN ID %u | FU_CIE |
| 07CC | 6176767 | ERROR | CAN: Frame rep. overflow IIM%u | FU_CIE |
| 07CD | 6176768 | ERROR | CAN: No RTR from CU | FU_CIE |
| 07CE | 6176769 | ERROR | CAN: rx signal conflict IIM%u | FU_CIE |
| 07CF | 6176770 | ERROR | CAN: tx timeout | FU_CIE |
| 07CI | | WARNING | CAN: IMPOSSIBLE ERROR | FU_CIE |
| 07CP | | WARNING | CAN: CPU: PXerr %d %s(%d) | FU_CIE |
| 07CR | | WARNING | CAN: CPU: message request fail | FU_CIE |
| 07CS | | WARNING | CAN: CPU: message send error | FU_CIE |
| 07CY | 6176789 | ERROR | CAN: rx abort IIM%u | FU_CIE |
| 07CZ | | WARNING | CAN: Unexpected frame (IIM%u) | FU_CIE |
| 07DA | 6176865 | ERROR | CAN: Chip access error | FU_CIE |
| 07DB | 6176866 | ERROR | CAN: Chip reset error | FU_CIE |
| 07DC | 6176867 | ERROR | CAN: Chip reset release error | FU_CIE |
| 07DE | | WARNING | CAN: Illegal interrupt pointer | FU_CIE |
| 07DF | 6176870 | ERROR | CAN: Chip state undefined | FU_CIE |
| 07DG | | WARNING | CAN: Chip err act. after pass. | FU_CIE |
| 07DH | | WARNING | CAN: Chip state error passive | FU_CIE |
| 07DI | | WARNING | CAN: Chip state bus-OFF | FU_CIE |
| 07DJ | 6176874 | ERROR | CAN: Chip DPRAM error | FU_CIE |
| 07DK | | WARNING | CAN: Chip DPRAM error&passive | FU_CIE |
| 07DL | | WARNING | CAN: Unexpected interrupt | FU_CIE |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.



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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 07LA | | WARNING | CV received IIM unknown | FU_CIE |
| 07LB | | WARNING | RC stator number out of range | FU_CIE |
| 07LC | | WARNING | RC stator not available | FU_CIE |
| 07LD | 6177668 | ERROR | RC stator 1 readback failed | FU_CIE |
| 07LE | 6177669 | ERROR | RC stator 2 readback failed | FU_CIE |
| 07LF | 6177670 | ERROR | RC stator 3 readback failed | FU_CIE |
| 07LG | | WARNING | RC speed value out of range | FU_CIE |
| 07LH | 6177672 | ERROR | RC speed set timeout | FU_CIE |
| 07LI | | WARNING | RC maximal stator load exceeded | FU_CIE |
| 07LJ | 6177674 | ERROR | RC maximal rotation time exceeded | FU_CIE |
| 07LK | | WARNING | AM amplimat chamber number out of range | FU_CIE |
| 07LL | | WARNING | AM amplimat field number out of range | FU_CIE |
| 07LM | | WARNING | AM amplimat delay value out of range | FU_CIE |
| 10CA | 6156765 | ERROR | CAN: Case-selector error | FU_RC |
| 10CB | | WARNING | CAN: Invalid CAN ID %u | FU_RC |
| 10CC | 6156767 | ERROR | CAN: Frame rep. overflow IIM%u | FU_RC |
| 10CD | 6156768 | ERROR | CAN: No RTR from CU | FU_RC |
| 10CE | 6156769 | ERROR | CAN: rx signal conflict IIM%u | FU_RC |
| 10CF | 6156770 | ERROR | CAN: tx timeout | FU_RC |
| 10CI | | WARNING | CAN: IMPOSSIBLE ERROR | FU_RC |
| 10CP | | WARNING | CAN: CPU: PXerr %d %s(%d) | FU_RC |
| 10CR | | WARNING | CAN: CPU: message request fail | FU_RC |
| 10CS | | WARNING | CAN: CPU: message send error | FU_RC |
| 10CY | 6156789 | ERROR | CAN: rx abort IIM%u | FU_RC |
| 10CZ | | WARNING | CAN: Unexpected frame (IIM%u) | FU_RC |
| 10DA | 6156865 | ERROR | CAN: Chip access error | FU_RC |
| 10DB | 6156866 | ERROR | CAN: Chip reset error | FU_RC |
| 10DC | 6156867 | ERROR | CAN: Chip reset release error | FU_RC |
| 10DE | | WARNING | CAN: Illegal interrupt pointer | FU_RC |
| 10DF | 6156870 | ERROR | CAN: Chip state undefined | FU_RC |
| 10DG | | WARNING | CAN: Chip err act. after pass. | FU_RC |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.


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| Error Code[1] | Error Code[2] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 10DH | | WARNING | CAN: Chip state error passive | FU_RC |
| 10DI | | WARNING | CAN: Chip state bus-OFF | FU_RC |
| 10DJ | 6156874 | ERROR | CAN: Chip DPRAM error | FU_RC |
| 10DK | | WARNING | CAN: Chip DPRAM error & passive | FU_RC |
| 10DL | | WARNING | CAN: Unexpected interrupt | FU_RC |
| 10FB | 6157066 | ERROR | Short circuit detected | FU_RC |
| 10FT | | WARNING | Overcurrent detected | FU_RC |
| 10IF | | WARNING | Initialization failed | FU_RC |
| 10LA | | WARNING | Acceleration count limit exceeded | FU_RC |
| 10LH | 6157672 | ERROR | Phase current %u mA (>%u) | FU_RC |
| 10LL | 6157676 | ERROR | Phase current %u mA (<%u) | FU_RC |
| 10LO | 6157679 | WARNING ERROR | Intermediate voltage %u V (>%u) | FU_RC |
| 10LT | 6157684 | ERROR | Temperature limit exceeded | FU_RC |
| 10LU | 6157685 | WARNING ERROR | Intermediate voltage %u V (<%u) | FU_RC |
| 10LZ | 6157690 | ERROR | Temperature sensor failure | FU_RC |
| 10OE | | WARNING | CPU: PXROS error %d | FU_RC |
| 10OF | | WARNING | CPU: PXROS error %d %s(%d) | FU_RC |
| 10RC | 6158267 | ERROR | Rotation check failed | FU_RC |
| 10RI | 6158273 | ERROR | Invalid rotation request: %u | FU_RC |
| 10RT | 6158284 | ERROR | Rotation request timeout | FU_RC |
| 10TD | 6158468 | ERROR | Invalid data for tube %u | FU_RC |
| 10TE | 6158469 | ERROR | Stator %u hardware error | FU_RC |
| 10TF | 6158470 | ERROR | Stator %u switching failed | FU_RC |
| 10TI | 6158473 | ERROR | Invalid stator request: %u | FU_RC |
| 10TR | 6158482 | ERROR | Stator change with rotating anode | FU_RC |
| 10UI | | WARNING | Unknown message from CU: IIM %u | FU_RC |
| 10UM | | WARNING | Unexpected message from CU: IIM %u | FU_RC |
| 10WT | | WARNING | CPU: Watchdog timeout | FU_RC |
| 10XX | | WARNING | IMPOSSIBLE ERROR | FU_RC |

1) As it occurs in the error log and within XRGSCOPE.

2) As it occurs on the COCKPIT desk.



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2. Errors as they occur on the COCKPIT control desk, in the error trace and in XRGSCOPE, sorted by numerical code.

| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6106648 | 00B0 | ERROR | CPU: Error in application data service interface | CU |
| 6106657 | 00B9 | ERROR | AD: Message from unknown function unit (FU) | CU |
| 6106680 | 00BP | ERROR | AD: Unknown message from system controller | CU |
| 6106865 | 00DA | ERROR WARNING | No CPU-Access to CAN-chip | CU |
| 6106869 | 00DE | ERROR WARNING | Unexpected CAN-chip int-pointer | CU |
| 6106873 | 00DI | ERROR | CAN-chip state bus-OFF #1H | CU |
| 6106876 | 00DL | ERROR | Unexpected CAN-chip interrupt | CU |
| 6106984 | 00E0 | ERROR | iRMX exception #2#1H occurred | CU |
| 6107149 | 00G1 | ERROR | Condition_code <> OK after CALL to send | CU |
| 6107352 | 00I4 | ERROR | One FU has a WD-error | CU |
| 6107449 | 00J1 | ERROR | DI: Unknown IIM #1H | CU |
| 6107450 | 00J2 | ERROR | DI: rx LWDR param out of range FS= #1H PID= #2H | CU |
| 6107451 | 00J3 | ERROR | DI: rx LWDR message corrupted FS= #1H PID= #2H | CU |
| 6107452 | 00J4 | ERROR | DI: Internal table lookup failed FS= #1H PID= #2H | CU |
| 6107454 | 00J6 | ERROR | DI: tx LWDR param error FS= #1H PID= #2H ER= #3H | CU |
| 6107455 | 00J7 | ERROR | DI: LWDR message creation failed | CU |
| 6107466 | 00JB | ERROR | DI: Unknown LWDR message received FS= #1H | CU |
| 6107467 | 00JC | ERROR | DI: tx LWDR message size invalid FS= #1H | CU |
| 6107649 | 00L1 | ERROR | GC: Checksum error | CU |
| 6107650 | 00L2 | ERROR | GC: Data access error | CU |
| 6107651 | 00L3 | ERROR | GC: Limit data error | CU |
| 6107652 | 00L4 | ERROR | GC: Limits inconsistent | CU |
| 6107653 | 00L5 | ERROR | GC: Calculation error | CU |
| 6107654 | 00L6 | ERROR | GC: Function not implemented | CU |
| 6107748 | 00M0 | ERROR | Unable to initialize FU(s) #1H, #2H, #3H, #4H, #5H, #6H | CU |
| 6107749 | 00M1 | ERROR | Configuration key is missing or defective | CU |
| 6107751 | 00M3 | ERROR | No response at all from FU(s) #1H, #2H, #3H, #4H, #5H, #6H | CU |
| 6107752 | 00M4 | ERROR | Function value from SE out of range | CU |
| 6107753 | 00M5 | ERROR | Procedure index from SE out of range | CU |
| 6107772 | 00MH | ERROR | Job incorrectly identified | CU |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.


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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6108068 | 00PD | ERROR | PC comm.: Unknown TDL proc id | CU |
| 6108348 | 00S0 | ERROR | PC comm.: Tube programming error | CU |
| 6108363 | 00S? | ERROR | PC comm.: Unexpected error | CU |
| 6108365 | 00SA | ERROR | PC comm.: Not enough space at destination segment | CU |
| 6108367 | 00SC | ERROR | PC comm.: Value too large | CU |
| 6108368 | 00SD | ERROR | PC comm.: Terminator not found | CU |
| 610836 | 00SE | ERROR | PC comm.: Error in description | CU |
| 6108370 | 00SF | ERROR | PC comm.: Item type unknown | CU |
| 6108371 | 00SG | ERROR | PC comm.: Internal type unknown | CU |
| 6108372 | 00SH | ERROR | PC comm.: Value negative | CU |
| 6108374 | 00SJ | ERROR | PC comm.: Syntax wrong | CU |
| 6108375 | 00SK | ERROR | PC comm.: String too long | CU |
| 6108378 | 00SN | ERROR | PC comm.: FU reference table full | CU |
| 6108379 | 00SO | ERROR | PC comm.: Node ID unknown | CU |
| 6108380 | 00SP | ERROR | PC comm.: FU code unknown | CU |
| 6108381 | 00SQ | ERROR | PC comm.: Syntax error in node ID | CU |
| 6108383 | 00SS | ERROR | PC comm.: Request not performed | CU |
| 6108384 | 00ST | ERROR | PC comm.: RMX error | CU |
| 6108386 | 00SV | ERROR | PC comm.: Mail corrupted | CU |
| 6108387 | 00SW | ERROR | PC comm.: Procedure ID unknown | CU |
| 6108388 | 00SX | ERROR | PC comm.: FU mA incompatible | CU |
| 6108389 | 00SY | ERROR | PC comm.: FU OFF request failed | CU |
| 6108390 | 00SZ | ERROR | PC comm.: Wrong response | CU |
| 6108463 | 00T? | ERROR | TTS: Unexpected Error | CU |
| 6108465 | 00TA | ERROR | TTS: Received message unknown | CU |
| 6108466 | 00TB | ERROR | TTS: Tube supervision error from FU kV | CU |
| 6108467 | 00TC | ERROR | TTS: Internal TTS error | CU |
| 6108468 | 00TD | ERROR | TTS: Tube number unknown | CU |
| 6108469 | 00TE | ERROR | TTS: NVRAM checksum error | CU |
| 6108470 | 00TF | ERROR | TTS: NVRAM unavailable | CU |
| 6108471 | 00TG | ERROR | TTS: Tube overheated | CU |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.



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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6108848 | 00X0 | ERROR | CPU: Wrong timer id | CU |
| 6108849 | 00X1 | ERROR | CPU: Wrong timer mode | CU |
| 6108850 | 00X2 | ERROR | CPU: Wrong message type | CU |
| 6108852 | 00X4 | ERROR WARNING | Timeout of X-ray backup timer | CU |
| 6108873 | 00XI | ERROR | Init with FU-RoCo not OK | CU |
| 6108874 | 00XJ | ERROR WARNING | Exposure time too short | CU |
| 6108879 | 00XO | ERROR | Exposure time too long | CU |
| 6108885 | 00XU | ERROR | Transition endless loop | CU |
| 6108887 | 00XW | ERROR | EN_X active in startup | CU |
| 6108888 | 00XX | ERROR | RD_PR_X stays active after prep | CU |
| 6126567 | 02AC | ERROR | Wrong index for table access | FU_kV |
| 6126568 | 02AD | ERROR | Wrong do case entry | FU_kV |
| 6126965 | 02EA | ERROR | Interrupt 0: Divide by zero | FU_kV |
| 6126966 | 02EB | ERROR | Interrupt 1: Single step | FU_kV |
| 6126967 | 02EC | ERROR | Interrupt 2: NMI | FU_kV |
| 6126968 | 02ED | ERROR | Interrupt 3: Breakpoint | FU_kV |
| 6126969 | 02EE | ERROR | Interrupt 4: Overflow exception | FU_kV |
| 6126970 | 02EF | ERROR | Interrupt 5: Array bounds exception | FU_kV |
| 6126971 | 02EG | ERROR | Interrupt 6: Unused opcode | FU_kV |
| 6126972 | 02EH | ERROR | Interrupt 7: ESC opcode | FU_kV |
| 6126973 | 02EI | ERROR | CAN connection to CU lost | FU_kV |
| 6127266 | 02HB | ERROR | kV nominal value out of range | FU_kV |
| 6127268 | 02HD | ERROR | Z nominal value out of range | FU_kV |
| 6127270 | 02HF | ERROR | kV value during standby too large | FU_kV |
| 6127272 | 02HH | ERROR | kV actual value out of range | FU_kV |
| 6127274 | 02HJ | ERROR | E value during standby out of range | FU_kV |
| 6127276 | 02HL | ERROR | E value during high tension out of range | FU_kV |
| 6127278 | 02HN | ERROR | Converter 1 temperature out of range | FU_kV |
| 6127280 | 02HP | ERROR | Converter 2 temperature out of range | FU_kV |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.


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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6127282 | 02HR | ERROR | High voltage tank temperature out of range | FU_kV |
| 6127284 | 02HT | ERROR | Divider test cathode out of range | FU_kV |
| 6127286 | 02HV | ERROR | Divider test anode out of range | FU_kV |
| 6127288 | 02HX | ERROR | kV asymmetrical | FU_kV |
| 6127765 | 02MA | ERROR | State request not accepted because of grid mode | FU_kV |
| 6127766 | 02MB | ERROR | State request not accepted because of error state | FU_kV |
| 6127965 | 02OA | ERROR | RMX error: Timeout | FU_kV |
| 6127966 | 02OB | ERROR | RMX error: Memory | FU_kV |
| 6127967 | 02OC | ERROR | RMX error: Busy | FU_kV |
| 6127969 | 02OE | ERROR | RMX error: Limit | FU_kV |
| 6127970 | 02OF | ERROR | RMX error: Context | FU_kV |
| 6127971 | 02OG | ERROR | RMX error: Exist | FU_kV |
| 6127972 | 02OH | ERROR | RMX error: State | FU_kV |
| 6127973 | 02OI | ERROR | RMX error: Not configured | FU_kV |
| 6127974 | 02OJ | ERROR | RMX error: Interrupt saturation | FU_kV |
| 6127975 | 02OK | ERROR | RMX error: Interrupt overflow | FU_kV |
| 6127976 | 02OL | ERROR | RMX error: Transmission | FU_kV |
| 6127977 | 02OM | ERROR | RMX error: Divide by zero | FU_kV |
| 6127978 | 02ON | ERROR | RMX error: Overflow | FU_kV |
| 6127979 | 02OO | ERROR | RMX error: Type | FU_kV |
| 6127980 | 02OP | ERROR | RMX error: Parameter | FU_kV |
| 6127981 | 02OQ | ERROR | RMX error: Bad call | FU_kV |
| 6127982 | 02OR | ERROR | RMX error: Array bound | FU_kV |
| 6127983 | 02OS | ERROR | RMX error: NDP error | FU_kV |
| 6127984 | 02OT | ERROR | RMX error: Illegal opcode | FU_kV |
| 6127985 | 02OU | ERROR | RMX error: Emulator trap | FU_kV |
| 6127986 | 02OV | ERROR | RMX error: Interrupt table limit | FU_kV |
| 6127987 | 02OW | ERROR | RMX error: CPU xfer data limit | FU_kV |
| 6127988 | 02OX | ERROR | RMX error: Wrap around | FU_kV |
| 6127989 | 02OY | ERROR | RMX error: Check exception | FU_kV |
| 6127990 | 02OZ | ERROR | RMX error: Unknown | FU_kV |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.



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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6128565 | 02UA | ERROR | HW configuration identifier wrong | FU_kV |
| 6128766 | 02WB | ERROR | Wrong tube selected | FU_kV |
| 6128768 | 02WD | ERROR | EN X C signal faulty | FU_kV |
| 6128770 | 02WF | ERROR | Wrong grid mode selected | FU_kV |
| 6128772 | 02WH | ERROR | Tube arcing detected | FU_kV |
| 6128774 | 02WJ | ERROR | kV over voltage detected | FU_kV |
| 6128776 | 02WL | ERROR | Tube supervision error | FU_kV |
| 6128777 | 02WM | ERROR | Tube supervision error | FU_kV |
| 6136965 | 03EA | ERROR | CPU interrupt 0 | FU_mA |
| 6136966 | 03EB | ERROR | CPU interrupt 1 | FU_mA |
| 6136968 | 03ED | ERROR | CPU interrupt 3 | FU_mA |
| 6136969 | 03EE | ERROR | CPU interrupt 4 | FU_mA |
| 6136970 | 03EF | ERROR | CPU interrupt 5 | FU_mA |
| 6136971 | 03EG | ERROR | CPU interrupt 6 | FU_mA |
| 6136972 | 03EH | ERROR | CPU interrupt 7 | FU_mA |
| 6136973 | 03EI | ERROR | CAN is unable to send an error to CU | FU_mA |
| 6137067 | 03FC | ERROR | No NVRAM plugged in | FU_mA |
| 6137165 | 03GA | ERROR | Limit error | FU_mA |
| 6137265 | 03HA | ERROR | Unknown hardware | FU_mA |
| 6137266 | 03HB | WARNING ERROR | Intermediate circuit voltage < 200V | FU_mA |
| 6137272 | 03HH | ERROR | If setpoint to large | FU_mA |
| 6137273 | 03HI | ERROR | If-actual out of tolerance | FU_mA |
| 6137274 | 03HJ | ERROR | If-actual out of tolerance | FU_mA |
| 6137276 | 03HL | ERROR | If-nominal out of tolerance | FU_mA |
| 6137277 | 03HM | ERROR | If-nominal out of tolerance | FU_mA |
| 6137278 | 03HN | ERROR | No retrigger received from CU | FU_mA |
| 6137965 | 03OA | ERROR | RMX exception: E$TIME | FU_mA |
| 6137966 | 03OB | ERROR | RMX exception: E$MEM | FU_mA |
| 6137967 | 03OC | ERROR | RMX exception: E$BUSY | FU_mA |
| 6137968 | 03OD | ERROR | RMX exception: E$LIMIT | FU_mA |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.


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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6137969 | 03OE | ERROR | RMX exception: E$CONTEXT | FU_mA |
| 6137970 | 03OF | ERROR | RMX exception: E$EXIST | FU_mA |
| 6137971 | 03OG | ERROR | RMX exception: E$STATE | FU_mA |
| 6137972 | 03OH | ERROR | RMX exception: E$NOT$CONFIGURED | FU_mA |
| 6137973 | 03OI | ERROR | RMX exception: E$INTERRUPT$SATURATION | FU_mA |
| 6137974 | 03OJ | ERROR | RMX exception: E$INTERRUPT$OVERFLOW | FU_mA |
| 6137975 | 03OK | ERROR | RMX exception: E$TRANSMISSION | FU_mA |
| 6137976 | 03OL | ERROR | RMX exception: E$ZERO$DIVIDE | FU_mA |
| 6137977 | 03OM | ERROR | RMX exception: E$OVERFLOW | FU_mA |
| 6137978 | 03ON | ERROR | RMX exception: E$TYPE | FU_mA |
| 6137979 | 03OO | ERROR | RMX exception: E$PARAM | FU_mA |
| 6137980 | 03OP | ERROR | RMX exception: E$BAD$CALL | FU_mA |
| 6137981 | 03OQ | ERROR | RMX exception: E$ARRAY$BOUND | FU_mA |
| 6137982 | 03OR | ERROR | RMX exception: E$NDP$ERROR | FU_mA |
| 6137983 | 03OS | ERROR | RMX exception: E$ILLEGAL$OPCODE | FU_mA |
| 6137984 | 03OT | ERROR | RMX exception: E$EMULATOR$TRAP | FU_mA |
| 6137985 | 03OU | ERROR | RMX exception: E$INTERRUPT$TABLE$LIMIT | FU_mA |
| 6137986 | 03OV | ERROR | RMX exception: E$CPUXFER$DATA$LIMIT | FU_mA |
| 6137987 | 03OW | ERROR | RMX exception: E$SEG$WRAP$AROUND | FU_mA |
| 6137988 | 03OX | ERROR | RMX exception: E$CHECK$EXCEPTION | FU_mA |
| 6137989 | 03OY | ERROR | Unknown RMX exception | FU_mA |
| 6138065 | 03PA | ERROR | Ie zero measured | FU_mA |
| 6138067 | 03PC | ERROR | Ie out of tolerance | FU_mA |
| 6138069 | 03PE | ERROR | Emergency OFF, grid not closed! | FU_mA |
| 6138070 | 03PF | ERROR | No kV discharged due to missing Ie | FU_mA |
| 6156765 | 10CA | ERROR | CAN: Case-selector error | FU_RC |
| 6156767 | 10CC | ERROR | CAN: Frame rep. overflow IIM%u | FU_RC |
| 6156768 | 10CD | ERROR | CAN: No RTR from CU | FU_RC |
| 6156769 | 10CE | ERROR | CAN: rx signal conflict IIM%u | FU_RC |
| 6156770 | 10CF | ERROR | CAN: tx timeout | FU_RC |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.



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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6156789 | 10CY | ERROR | CAN: rx abort IIM%u | FU_RC |
| 6156865 | 10DA | ERROR | CAN: Chip access error | FU_RC |
| 6156866 | 10DB | ERROR | CAN: Chip reset error | FU_RC |
| 6156867 | 10DC | ERROR | CAN: Chip reset release error | FU_RC |
| 6156870 | 10DF | ERROR | CAN: Chip state undefined | FU_RC |
| 6156874 | 10DJ | ERROR | CAN: Chip DPRAM Error | FU_RC |
| 6157066 | 10FB | ERROR | Short circuit detected | FU_RC |
| 6157672 | 10LH | ERROR | Phase current %u mA (>%u) | FU_RC |
| 6157676 | 10LL | ERROR | Phase current %u mA (<%u) | FU_RC |
| 6157679 | 10LO | WARNING ERROR | Intermediate voltage %u V (>%u) | FU_RC |
| 6157684 | 10LT | ERROR | Temperature limit exceeded | FU_RC |
| 6157685 | 10LU | WARNING ERROR | Intermediate voltage %u V (<%u) | FU_RC |
| 6157690 | 10LZ | ERROR | Temperature sensor failure | FU_RC |
| 6158267 | 10RC | ERROR | Rotation check failed | FU_RC |
| 6158273 | 10RI | ERROR | Invalid rotation request: %u | FU_RC |
| 6158284 | 10RT | ERROR | Rotation request timeout | FU_RC |
| 6158468 | 10TD | ERROR | Invalid data for tube %u | FU_RC |
| 6158469 | 10TE | ERROR | Stator %u hardware error | FU_RC |
| 6158470 | 10TF | ERROR | Stator %u switching failed | FU_RC |
| 6158473 | 10TI | ERROR | Invalid stator request: %u | FU_RC |
| 6158482 | 10TR | ERROR | Stator change with rotating anode | FU_RC |
| 6176765 | 07CA | ERROR | CAN: Case-selector error | FU_CIE |
| 6176767 | 07CC | ERROR | CAN: Frame rep. overflow IIM%u | FU_CIE |
| 6176768 | 07CD | ERROR | CAN: No RTR from CU | FU_CIE |
| 6176769 | 07CE | ERROR | CAN: rx signal conflict IIM%u | FU_CIE |
| 6176770 | 07CF | ERROR | CAN: tx timeout | FU_CIE |
| 6176789 | 07CY | ERROR | CAN: rx abort IIM%u | FU_CIE |
| 6176865 | 07DA | ERROR | CAN: Chip access error | FU_CIE |
| 6176866 | 07DB | ERROR | CAN: Chip reset error | FU_CIE |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.


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| Error Code[3] | Error Code[4] | Error Class | Error Text | FU |
|---|---|---|---|---|
| 6176867 | 07DC | ERROR | CAN: Chip reset release error | FU_CIE |
| 6176870 | 07DF | ERROR | CAN: Chip state undefined | FU_CIE |
| 6176874 | 07DJ | ERROR | CAN: Chip DPRAM error | FU_CIE |
| 6177668 | 07LD | ERROR | RC stator 1 readback failed | FU_CIE |
| 6177669 | 07LE | ERROR | RC stator 2 readback failed | FU_CIE |
| 6177670 | 07LF | ERROR | RC stator 3 readback failed | FU_CIE |
| 6177672 | 07LH | ERROR | RC speed set timeout | FU_CIE |
| 6177674 | 07LJ | ERROR | RC maximal rotation time exceeded | FU_CIE |

3) As it occurs on the COCKPIT desk.

4) As it occurs in the error log and within XRGSCOPE.



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## 7.3. Elimination of error numbers

**00PL:**
The message 00PL (error of the AEC signal) may be a ”warning” or an “error”. It depends on the disturbance of the AEC signal.
The AEC signal can be measured at pin EZ150 X4 (signal) to EZ150 X3 (see also Z1-6 ”Basic interface”).

**When using measuring chambers there are three possibilities to get the error “00PL”:**

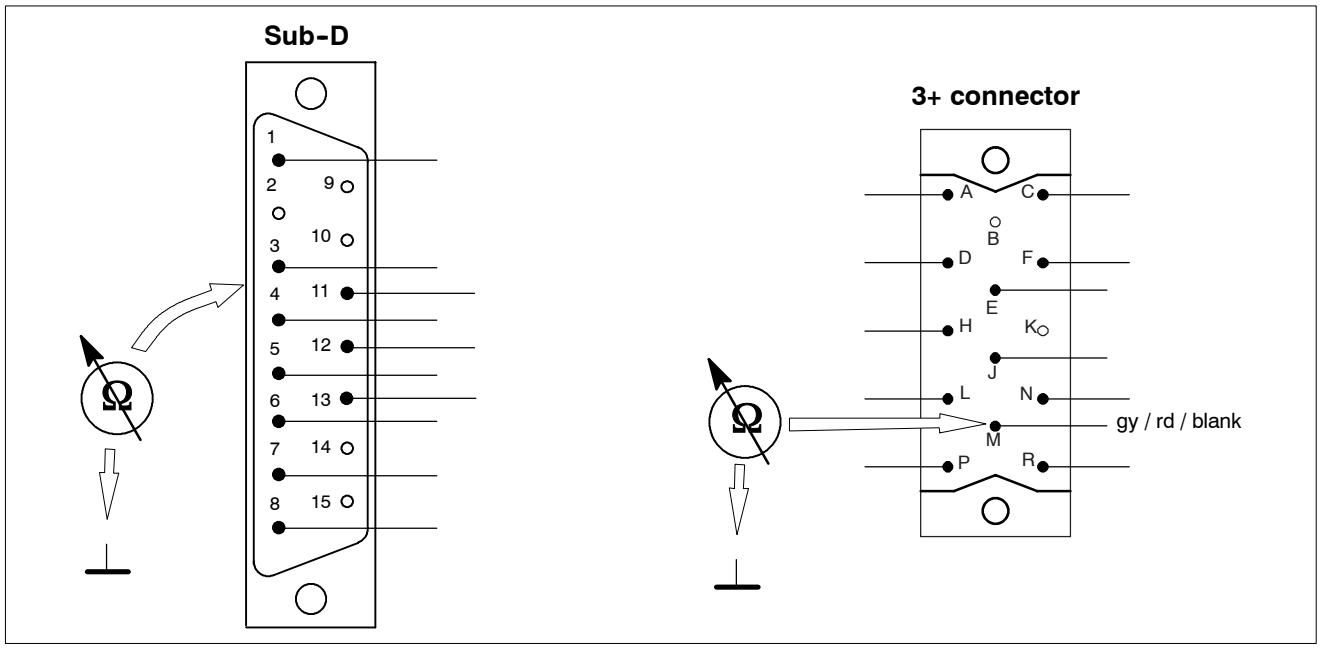
1. The shielding of the measuring chamber has a connection to system ground at the measuring chamber or interconnection.
2. In the cable to the measuring chamber is a missing ground connection.
   (This mistake is not possible with the ACL chamber type No. 9890 000 016xx).
3. The measuring chamber is defective.

**Localization and elimination of the error source:**

Re 1.)

- Remove the connector of the measuring chamber at the generator side.
- Measure connection:
  - **shielding** (Sub-D connector, 15 pins) to **system ground**
    or
  - pin **M** (3+ connector, 14 pins) to system ground ===> **The connection must not be present!**

- Measure connection:
  - **shielding** (Sub-D connector, 15 pins) to **chamber shielding**
    or
  - pin **M** (3+ connector, 14 pins) to chamber shielding ===> **The connection must be present!**





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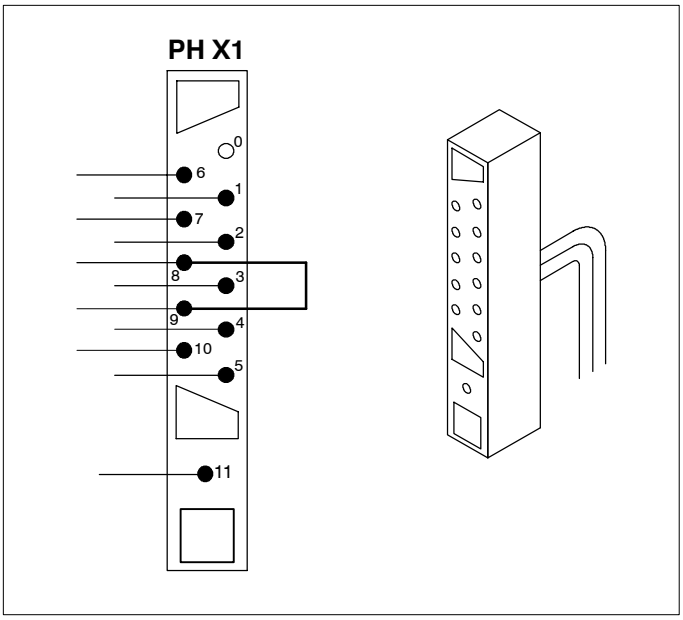
Re 2.)

The connector of the measuring chamber at the generator side has been removed.

- Measure the connection between pin **8** and pin **13** (Sub-D connector).
  **The connection must be present!**

- If the connection is not present, insert a link between pin **8** and **9** at the chamber connector at the chamber end as shown in the figure.
  In this case the system is most probably operated with an old hybrid measuring chamber
  9803 509 xxxxx instead of an ACL measuring chamber 9890 000 016xx. In hybrid measuring chambers the connection between pin **8** <-> **9** is missing.




In case a 3+ connector is used, the connection pin **N** <-> **J** is most probably missing because this connection is not present in hybrid measuring chambers.

To increase interference protection establish the above mentioned connection at the chamber connector of the chamber cable pin **8** <-> **9** in addition to the connection in the adapter for the AMPLIMAT cable (see Z1 “Basic interface”).

Re 3.):

Use a test chamber and compare the function.



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# 8. Power supply

**Warning!**
**During fault finding within the power supply unit be very careful the unit is still connected to the mains.**

## 8.1. Switch ON not possible

- ENF1 not switched ON (visual check)
- ENF1 released
  - check for damage before reactivating ENF1/2 (visual check, any smell?)
- ENF2 not switched ON (visual check)
- ENF2 released by
  - low-voltage supply
  - filament circuit
  - tube extension
  - external components supply

  → check for damage before reactivating ENF1/2 (visual check, any smell?)
- ON circuit EN100 defective

**Phase supervision:**

1. Without mains adaptation transformer

   - Phase L1 is missing: Mains contactors ENK2 and ENK1 cannot be activated.
   - Phase L2 is missing: The generator can be switched ON but does not go into the READY state. The filament-circuit supply is missing. There is an error message from function unit kV.
   - Phase L3 is missing: ON circuit without supply voltage.

   • Fault tracing:
   Check leads and fuses up to the mains supply.

2. With mains adaptation transformer

   • In case at least one phase at the primary end is missing, the generator cannot be switched ON. If there is a problem concerning the leads at the secondary end, refer to section 1 “INTRODUCTION AND TECHNICAL DATA”.


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## 8.2. After switch ON or attempted switch ON

The generator cannot be brought into the READY state (e.g. no desk display).

- Check the low-voltage supply.
- Check for released ENF1:
  Ground fault / short-circuit of one / several phase(s).
  Check ENK2 and, if necessary, the contacts of ENK1.
  Check the leads and the mains adaptation transformer.
  Check visually whether the contacts of ENK2 or ENK1 have dropped out.
- Check for missed voltage of intermediate-circuit:
  The damping resistors are unsoldered which was caused by overcurrent during switch ON.
  Cause: Short-circuit in the converter, defective charging capacitors, mains-filter capacitors or rectifiers.
  Unsoldering happens about 45s after switch ON.

The damping resistors are unsoldered because the converter was active and ENK1 was not switched ON although activated by the software.
Probably termination of exposure.

This procedure can only happen once because the generator cannot go into STANDBY mode when intermediate-circuit voltage E is missing.

In case intermediate-circuit voltage E is present, ENK1 is activated by the software of the kV-control and remains activated for the complete time the unit is in operation.

In case of high impedance or the tolerance of the symmetry resistors of the intermediate-circuit capacitor battery is too large, capacitors may be destroyed by overvoltage. In case ENK1 has already been activated, ENF1 probably releases.

ENF3 is released by the rotor control units.

The release of ENF2 switches the generator OFF because the supply voltage for the ON circuit and, consequently, the supply voltage of contactors ENK2 and ENK1 is interrupted.

A converter test kit OPTIMUS is available to determine possible problems with the converter, the HT transformer or the tube.
Order no.: 4512 104 9168x



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# 9. Functional description of function unit mA

Tube data must be loaded as a data set from floppy disk via PC and central unit CU into function unit mA.

The procedures described below cannot be carried out before the complete data set for the tube housing assembly is present in central unit CU.

Before the tube adaptation can be started, tube conditioning must be implemented as described in section 2, chapter 8.3.1.

Before adaptation is started, the mA offset value of the mA measuring circuit has to be determined.

This offset value consists of two components:

1. A current of 4mA is impressed upon the mA measuring circuit which is used for continuous calibration (during STANDBY about once per minute).
2. Additionally the kV measuring circuit delivers an offset current depending on the kV.

To measure this total value an exposure is released with 40kV and 500mA filament current. The emission current measured is the correction value for all standard exposures (4mA, measuring circuit current depending on the kV).

As opposed to the standby filament current value of the predecessor versions of generators, the standby filament current value of the Optimus generator is not fixed.

It is determined for each focus individually. A 40kV exposure is released with the focus to be measured while all other foci are switched OFF.

The filament current changes until an emission current of 100μA is obtained.

The associated filament current value is the individual standby filament current (1% to be substracted so that the fluoroscopic current of any of the other foci is not affected).

The following adaptation program takes place fully automatically.

Based on 120 single exposures for each focus a data field is created in the CMOS of function unit mA. The adjustments for all other exposures are interpolated from this data field during operation.

During the adaptation procedure all limit values such as maximum filament current, maximum kV, maximum tube load, maximum output, current of the generator etc. are taken into account.


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## Boost adaptation

### Boost time determination: Positive boosting

With the predecessor versions of generators, a calculated boost current was added to the exposure filament current for a fixed time of 400ms.

With Optimus generators the boost current is always fixed but with a variable time.

The amount of the boost current is the sum of the maximum filament current (of the respective filament) plus 2000mA.

To determine the time values an exposure must be started at a kV stage from which on the filament current does not have to be increased anymore to obtain the max. kV dependent emission current.

As soon as the 100% kV value is reached, the filament current jumps from the STANDBY value to the maximum filament current plus 2000mA. The emission current is measured every 2ms until the maximum tube current or the maximum possible tube current is reached.

In case this procedure takes too long (warming up of the tube), the measurement is continued with a second exposure after a sufficient period of time has passed.

The measurement starts again at the value obtained last.

### Boost time determination: Negative boosting

An innovation of the Optimus generator is the determination of the negative boosting (blanking of the filament current).

The measurement is started at the same kV stage as for the positive boost time but with maximum filament current.

As soon as the 100% kV value is reached, the maximum filament current of the filament jumps down to 500mA.

Every 2ms the emission current is measured until a value of 100µA is obtained.

The values for the blanking times are required for techniques such as, for instance, cine.

A filament current value of 500mA must not be exceeded for otherwise the output to supply a gridswitch box (which might be present) is too low.

The following procedure takes place after the generator has been switched ON:

Function unit mA initializes itself and afterwards establishes connection with central unit CU via CAN.

For 3s every focus is boosted with the respective specified maximum filament current. Then blanking of the filament current (500mA) takes place for a variable period of time (derived from negative boost adaptation) to bring the filament current to the STANDBY value (large focus first followed by a smaller one).

The change of the filament current value upon a change of the focus which was the usual routine for the predecessor versions of the Optimus generator does no longer take place. All STANDBY values remain constant.

During operation the following procedure takes place after the release of PREPARATION:

The filament current rises from the individual STANDBY filament current to the boost current.

The switch ON time of the boost current depends on the difference between STANDBY and the exposure (single boost) or intermediate filament (double boost) current.

### Double boost

- The intermediate filament current is a calculated value. It is calculated in such a way that the filament current and thus the filament temperature is brought to exposure level when the boost current is switched ON for another 50ms by the exposure command.
- During exposure the filament current regulates as required.
- At the end of exposure the filament current is reduced to the minimum value of 500mA (negative boosting) for a calculated time to bring it from the exposure to the STANDBY value.
- In case PREPARATION is released, negative boosting takes place until heating can go on with the STANDBY filament current.



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# 10. CAN bus

All the intelligent assemblies and PCBs communicate via the CAN bus. There they are connected in parallel to the two lines CAN_L (low) and CAN_H (high).

The data are serially transmitted in the form of so-called frames.

Levels in quiescent status against chassis:

CAN_L: 2.5V

CAN_H: 2.5V

Levels during data transmission against chassis:

CAN_L: 0.50 ... 2.25V
CAN_H: 2.75 ... 4.50V
} Both levels are opposite. The difference must be > 1.5V!

| Test points generator CAN | | Test points system CAN | |
|---|---|---|---|
| CAN_L: | EZX71 | S_CAN_L: | EZX42:2 |
| CAN_H: | EZX72 | S_CAN_H: | EZX42:7 |
| Chassis: | EZX5 | Chassis: | EZX42:3 |

Reference: Z1-5.1, Z2-5.x

**Symptoms of errors:**

- The generator is inoperable.
- The red LEDs of one or more of the assemblies or PCBs flash.
- Parameter settings at the control desk are accepted and displayed with a considerable delay.
- In the error memory are several entries which code begins with 00C (apart from 00CJ) or the error description contains a reference to signal conflicts.

**Error localization:**

1. Entries in the error memory clearly indicate that the assembly and PCB are not communicating properly or not at all.

2. Control measurement of CAN levels with an oscilloscope during data transmission and in the quiescent status: Data transmission is triggered by pressing any desk button.
   If the levels are outside the tolerance or are not symmetrical, the CAN driver of an assembly or PCB is faulty. Because all the users are connected to the bus in parallel, the troublemaker can only be found by disconnecting one user after another.

**Caution!**
**Disconnection must only take place with the generator switched OFF.**


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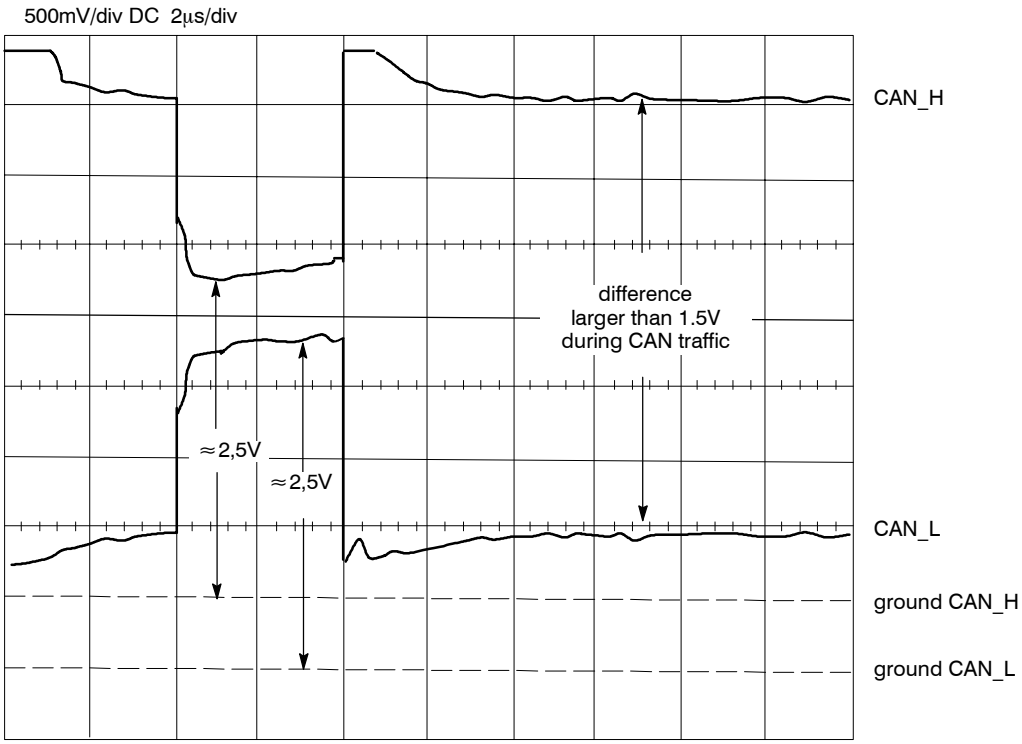
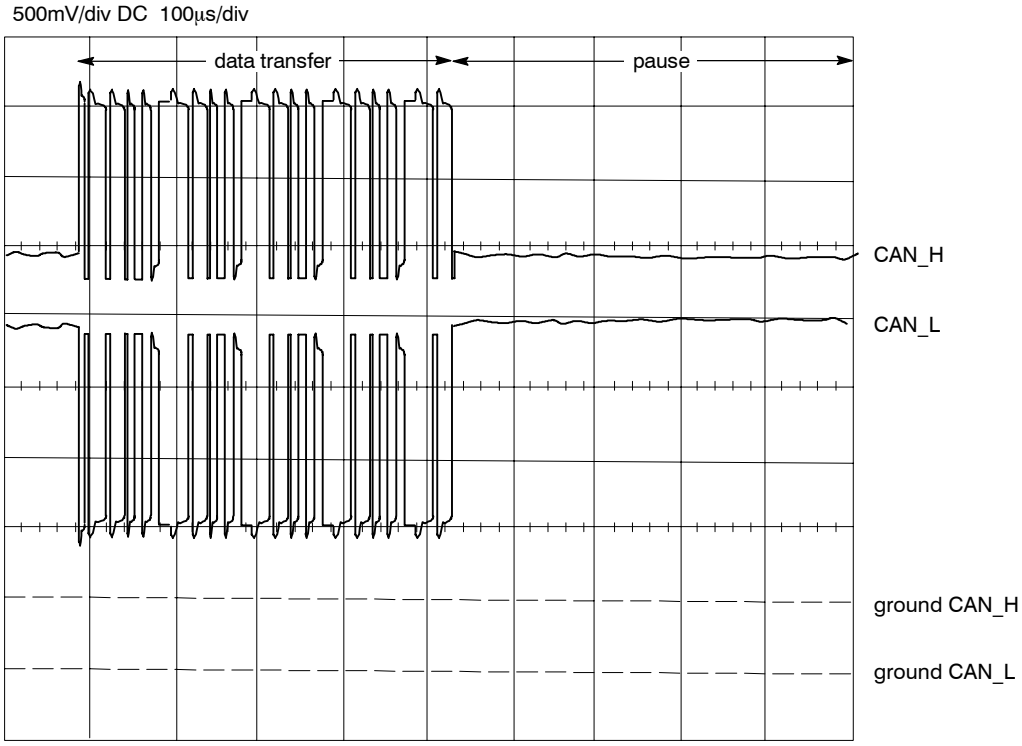
CAN levels with a high temporal resolution:
(Diagram 1)




CAN levels with low temporal resolution:
(Diagram 2)

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# 11. Incorrect exposure indicator

**General causes:**

An incorrect exposure is indicated on the control desk if an exposure cannot be terminated according to the parameters set. Frequent causes of underexposure are the following:

1. The operator lets go of the release switch prematurely.
2. The measuring chamber is incorrectly programmed, not connected or faulty.

   Check the following:
   - Programming of Amplimat sensitivity
   - Programming of EZ150 basic interface (gain, 15V/40V-supply)
   - Programming of screen/film combination (data set 1 ... 5)

**Fault exposure detection AEC / TDC:**

To protect patients there are 3 monitoring systems for automatic techniques:

1. Maximum mAs product: Can be set by XRGSCOPE
2. Maximum exposure time or backup time: Can be set by XRGSCOPE
3. Fault exposure detection: The fault exposure detection can be switched ON or OFF via XRGSCOPE. Irrespective of this fault exposure detection does not perform if levels fall below certain limits.

**AEC / AECF limits:**

- Maximum mAs product: 580mAs (default)
- Maximum exposure time: 4s (cannot be changed)
- Backup time AEC: Exposure time based on 9.5 times the mAs of the respective manual technique (kV-mAs). 4s after overriding
- Backup time AECF: 9.5 times the exposure time of the respective manual technique (kV-mAs)
- Fault exposure detection: ≤ 4% dose at 10% backup time

Fault exposure detection is ignored under the following circumstances:

- Backup time: ≤ 100ms (≤ 10ms at 10%)
- Switch OFF voltage (dose): ≤ 610mV (≤ 24.4mV at 4%)

If there is a fault an exposure is aborted after about 10% of backup time. If the fault exposure detection fails to respond in the event of a fault, shutdown takes place after reaching backup time, max. exposure time or max. mAs product.


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**TDC limits:**

- Maximum mAs product: 580mAs (default)
- Exposure time: 0.3 ... 6s
- Fault exposure detection: ≤ 10 ... 4% dose for 9.5 times the sample time

$$\text{dose minimum} = \frac{9.5 \times \text{sample time}}{\text{exposure time (corr.)}} \times 40\% \text{ nominal dose}$$

- Backup time: Exposure time
- Sample time: 25 ... 60ms = 1% exposure time (corr.); min. 25ms
- Sample steps: 12 ... 100

Fault exposure detection is ignored under the following circumstances:

- Exposure time: < 1s

In the event of a fault the exposure is aborted after approx. 11 times sample time. If the fault exposure detection fails to respond in the event of a fault, shutdown takes place after reaching the backup time or the max. mAs product.

The switch OFF voltage should be at least 1.2V to guarantee good TDC regulation. Program the higher gain factor on EZ150 BASIC INTERFACE (≥ 4512 108 05964), if necessary.

**Programming possibilities:**

- Select menu:
  PROGRAM/ APPLICATION LIMITS/ **X-MODE LIMITS**

  X-Ray Mode: AEC ... TDC
  Max. Current Time Product Limit: 580mAs

- Select menu:
  PROGRAM/ DOSE RATE CONTROL/ FAULT EXPOSURE DETECTION/ **AEC ... TDC**

  ON - OFF

**Aids to fault finding:**

- Select menu:
  FAULTFIND/ LOGGING TABLE/ X-RAY LOG/ DOSE RATE CONTROL LOGGING/ ...

... **READ ACTUAL STATUS** Technique and parameters of the last exposure
... AEC/ **AEC CALCULATION** Data of the selected APR with AEC or AECF
... AEC/ **AEC TRACE** Control values of the last AEC exposure
... TDC/ **TDC CALCULATION** Data of the selected APR with TDC
... TDC/ **TDC TRACE** Control values of the last TDC exposure

**Adjustment possibilities:**

- Select menu:
  ADJUST/ DOSE RATE CONTROL/ **TDC AMPLIMAT**

P gain factor (def. 50):
i gain factor (def. 8):
d gain factor (def. 5):
} Do not change any value here without order from DMC Hamburg!

min. sample time (def. 40) [ms]: 25 ... 65


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# 12. Mnemonic and routing list

Explanation:

MNEMONIC
explanation
signal chain (–direct connection = connection via relay contact) all possible units mentioned
signal value / range / signal source
measuring point (in ( ) at PCB front panel)
trigger point [preferred]
remarks
part of supply

---

AC_0V_XG
AC mains supply 0 V X–ray generator
ENX1101/2–EZX13:2–EZ102X1:DBZ4–EZ119X1:DBZ24 Optimus RAD
ENX3201–EZX13:2–EZ102X1:DBZ4–EZ119X1:DBZ24 Optimus R/F
neutral N of mains supply for EZ102 + EZ119

---

AC_230V_L1
AC mains supply 230VAC phase 1
ENF2:L1–ENF2:T1–ENK2:2–ENK2:1–EZX13:1–EZX102X1:DBZ2
AC mains supply for low voltage power supply EZ102

---

AC_230V_L2
mains supply 230V AC phase 2
ENF2:L2–ENF2:T2–ENK2:4–ENK2:3–EZX13:3–EZ119X1:DBZ26
AC mains supply for function unit mA_control EZ119

---

AV_HT_AN
high tension actual value anode side
0V ... +3.75V = 0 ... 75kV 1V = 20kV
measuring point EZ130 (X4)
[CRTL_X_C/ at EZX74]

---

AV_HT_CA
high tension actual value cathode side
0V ... +3.75V = 0 ... 75kV 1V = 20kV
measuring point EZ130 (X5)
cathode value also positive!
[CRTL_X_C/ at EZX74]

---

AV_HT
high tension actual value
0 ... +7.5V = 0 ... 150kV 1V = 20kV
measuring point EZ130 (X3)
[CRTL_X_C/ at EZX74]

---


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CAN_H
generator CAN high active
-EZ119X2:C3-EZ130X2:C3-EZ139X2:C3-EZ150X2:C3-EZX44:10-EZX45:10-EZX46:10
-C300X1:10-EZX51:3-EZX151:3-EZX52:7-EZX72
-EWAX51:10-EWAX52:10-EWA100X2:C3-EWBX51:10-EWBX52:10-EWB100X2:C3
+2.5VDC standby, +3.2VDC during communication
EZX72
for communication of generator function units only
part of: XRG bus

---

CAN_L
generator CAN low active
-EZ119X2:A3-EZ130X2:A3-EZ139X2:A3-EZ150X2:A3-EZX44:2-EZX45:2-EZX46:2
-C300X1:2-EZX51:2-EZX151:2-EZX52:2-EZX71-EWAX51:2-EWAX52:2-EWA100X2:A3-EWBX51:2
-EWBX52:2-EWB100X2:A3
+2.5VDC standby, +1.5VDC during communication
EZX71
for communication of generator function units only
part of: XRG bus

---

CM_EX_SW_1
common for exposure switch of release decade 1
EWA100X1:C5-EWAX1:10
EWB100X1:C5-EWBX1:10
+26V non-active
exposure request

---

CM_EX_SW_2
common for exposure switch of release decade 2
EWA100X1:C7-EWAX2:10
EWB100X1:C7-EWBX2:10
+26V non-active
exposure request

---

CM_EX_SW_3
common for exposure switch of release decade 3
EWA100X1:C9-EWAX3:10
EWB100X1:C9-EWBX3:10
+26V non-active
exposure request

---

CM_EX_SW_4
common for exposure switch of release decade 4
EWA100X1:C11-EWAX4:10
EWB100X1:C11-EWBX4:10
+26V non-active
exposure request

---


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CM_SW
common for radiation indication
EZ150X1:C29-EZX1:6-EWGX1:6-EWGX2:6-EWGX3:6
partner of SW_UN_EX, potential free contact

---

CM_TH
common for thermal sensor of tube housing
NTC temperature measurement in tube housing (not yet available)
EZ130X1:C12-EZX3:7-EWGX7:7-EWGX8:7-EWGX9:7 backpanel 4512 108 05983
EZ130X1:C12-EZX3:4-EWGX7:4-EWGX8:4-EWGX9:4 backpanels 4512 108 05984 + 4512 108 09361/2
partner of TH_OL

---

CM_TH_SW
common for tube housing temperature switch
EZ130X1:C11-EZX3:4-EWGX7:4-EWGX8:4-EWGX9:4 backpanel 4512 108 05983
EZ130X1:C11-EZX3:7-EWGX7:7-EWGX8:7-EWGX9:7 backpanels 4512 108 05984 + 4512 108 09361/2
partner of TH_OL_SW/

---

COM_EX_CD
common for exposure end signal and other warning signals
EWB102X1:A12-EWBX22:6
partner of EX_CD + SW_XG_RD_1 + SW_PR_FL_1 + SW_WN_FL_1 + SW_UN_EX_1

---

CTRL_X/
control X–ray request command, system level or with decade adaptation units WA/WB
EZ139X1:A4-EZX23:4-EZX45:5-EWAX51:5-EWAX52:5-EWA100X2:C25-EWBX51:5-EWBX52:5
-EWB100X2:C25
0V active, +15V inactive
EZX85
part of: signal bus

---

CTRL_X_C/
control X–ray request command, internal generator signal
EZ119X2:C6-EZ130X2:C6-EZ139X2:C6-EZ150X2:C6-EZX52:8
0V active, +5V inactive
EZX74 as preferred trigger signal for kV measurement
final high tension on command if all conditions ready
part of: XRG bus, CAN/XS bus

---

CU_CT1_1
cooling unit contact 1_1
EZ150X1:A22-EZX2:6-EWGX4:6=EGWX5:6=EWGX6:6

---

CU_CT1_2
cooling unit contact 1_2
EZ150X1:C22-EZX2:7-EWGX4:7=EWGX5:7=EWGX6:7

---


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CU_U
stator current U
high speed rotor control units 4512 104 71421/461
EY100 X15
9.3A/V

---

CU_V
stator current V
high speed rotor control units 4512 104 71421/461
EY100 X16
9.3A/V

---

CU_W
stator current W
high speed rotor control units 4512 104 71421/461
EY100 X17
9.3A/V

---

CV1 EN/
CV2 EN/
converter 1/2 enable
converter 1: EZ130X1:A9-EZX24:22-EQ100X1:22
converter 2: EZ130X1:A30-EZX34:22-E2Q100X1:22
not used, no function

---

CV1_GND
converter power part 1 ground
EZ130X1:AC8-EZX24:8/21-EQ100X1:8/21
in combination with: CV2_ID/ signal release 2 generators
in combination with: CV2_IDA/ and CV2_IDB/ release 3 generators

---

CV1_GND_OL
converter power part 1 ground overload (generator basic version ≥ 4512 104 70203/70602)
EZ130X1:A7-EZX24:20-EQ100X1:20
not used, no function

---

CV1_ID/
converter power part 1 identification
EQ100X1:19-EZX24:19-EZ130X1:A6
open +5V, converter connected 0V
in combination with: CV1_GND signal
release 2 generators only

---

CV1_IDA/
converter power part 1 identification A
EQ100X1:19-EZX24:19-EZ130X1:A6
open +5V, converter connected +24mV
in combination with: CV1_GND signal
release 3 generators only

---


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CV1_IDB/
converter power part 1 identification B
EQ100X1:21-EZX24:21-EZ130X1:C9
open +5V, converter connected +24mV
in combination with: CV1_GND signal
release 3 generators only

---

CV2_IDA/
converter power part 2 identification A
E2Q100X1:19-EZX34:19-EZ130X1:A27
open +5V, converter connected +24mV
in combination with: CV2_GND signal
release 3 generators only

---

CV2_IDB/
converter power part 2 identification B
E2Q100X1:21-EZX34:21-EZ130X1:C30
open +5V, converter connected +24mV
in combination with: CV2_GND signal
release 3 generators only

---

CV1_OL/
converter power part 1 overload
EQ100X1:7-EZX24:7-EZ130X1:C7
not used, no function

---

CV1_TM
converter power part 1 temperature
EQ100X1:6-EZX24:6-EZ130X1:C6
4.4V ... 1.5V = 20 ... 100 degrees C
in combination with: CV1_GND signal

---

CV2_GND
converter power part 2 ground
EZ130X1:AC29-EZX34:8/21-E2Q100X1:8/21
in combination with: CV2_ID/ signal release 2 generators
in combination with: CV2_IDA/ and CV2_IDB/ release 3 generators

---

CV2_GND_OL
converter power part 2 ground overload (generator basic version ≥ 4512 104 70203/70602)
EZ130X1:A28-EZX34:20-E2Q100X1:20
not used, no function

---

CV2_ID/
converter power part 2 identification
E2Q100X1:19-EZX34:19-EZ130X1:A27
open +5V, converter connected 0V
in combination with: CV2_GND signal
release 2 generators only

---


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CV2_OL
converter power part 2 overload
E2Q100X1:7-EZX34:7-EZ130X1:C28
not used, no function

---

CV2_TM
converter power part 2 temperature
EZ130X1:C27-E2Q100X1:6-EZX34:6
4.4V...1.5V = 20...100 °C
in combination with: CV2_GND signal

---

DR_BV_0V
dose rate (signal) reference of image intensifier
EZX61:3-EZ139X2:C18 backpanel 4512 108 05983/4 only
negative potential of II unit, 0V +/-50mV against generator ground
differential signal with DR_BV_SG
not used, no function for generators release 2

---

DR_BV_NG
dose rate (signal) reference of image intensifier
EZX61:6-EZ139X2:C18 backpanel 4512 108 09361/2 only
negative potential of II unit, 0V +/-50mV against generator ground
differential signal with DR_BV_SG
part of: dose rate control

---

DR_BV_SG
dose rate signal of image intensifier
EZX61:8-EZ139X2:A18 backpanel 4512 108 05983/4 only
EZX61:4-EZ139X2:A18 backpanel 4512 108 09361/2 only
positive potential, 0 ... 10V
differential signal with DR_BV_NG
no function for generators release 2
part of: dose rate control

---

DR_FL_LO_1
dose rate fluoro lock-in 1
EWBX12:7-EWB100X1:A21

---

DR_FQ_NG
dose rate signal (pulses) negative
not used, no function

---

DR_FQ_PO
dose rate signal (pulses) positive
not used, no function

---

DR_LM
dose rate limiter
EWBX12:1-EWB100X1:A20
low_active if tubelift D76 / EZD on short SID (if tubelift option present)

---


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DR_TV_NG
dose rate of TV chain signal negative, fluoro control
(II/TV_adapter_PCB_X3:1-X2:8)-EZX61:8-EZ139X2:C19 backpanel 4512 108 09361/2
+/-12V minus polarity
dual voltage differential signal
typically +6V in standby coming from TV chain
+V for more dose, -V for less dose, 0V stable image
part of: dose rate control

DR_TV_NT
dose rate of TV chain signal negative, fluoro control
EZX61:4-EZ139X2:C19 backpanel 4512 108 05983/4
not used, no function

DR_TV_PO
dose rate of TV chain signal positive, fluoro control
(II/TV_adapter_PCB_X3:3-X2:7)-EZX61:7-EZ139X2:A19 backpanel 4512 108 09361/2
-/+12V positive polarity
dual voltage differential signal
typically -6V in standby coming from TV chain
-V for more dose, +V for less dose, 0V stable image
part of: dose rate control

DR_TV_PT
dose rate of TV chain signal positive, fluoro control
EZX61:9-EZ139X2:A19 backpanel 4512 108 05983/4
not used, no function

DS_BV_NG
dose (signal ramp) reference of image intensifier
(II/TV_adapter_PCB_X1:P –X2:3)-EZX61:3-EZ139X2:C17 backpanel 4512 108 09361/2
negative potential of II unit, 0V +/-50mV against generator ground
differential signal with DS_BV_SG
part of: dose rate control

DS_BV_0V
dose (signal ramp) reference of image intensifier
EZX61:2-EZ139X2C17 backpanel 4512 108 05983/4
not used, no function

DS_BV_SG
dose signal ramp of image intensifier signal
EZX61:7-EZ139X2:A17 backpanel 4512 108 05983/4
(II/TV_adapter_PCB_X1:R-X2:2)-EZX61:2-EZ139X2:A17 backpanel 4512 108 09361/2
0 ... 10V, polarity positive
differential signal with DS_BV_NG release 3 generators only
release 2 generators: not used, no function
part of: dose rate control


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DS_MC_0V
dose (signal ramp) reference of selected measuring chamber
EZ150X2:C16-EZ139X2:C16
negative potential of selected measuring chamber, 0V +/-50mV against generator ground
differential signal with DS_MC_SG

---

DS_MC_SG
dose signal ramp of selected measuring chamber
EZ150X2:A16-EZ139X2:A16
0 ... +12V
[EZ150 X4 against X5 ground]
differential signal with DS_MC_0V

---

E_NG_CV1
E value converter DC supply negative
converter 1 (frontal 50/65/80kW): EQ100X1:5-EZX24:5-EZ130X1:C5
0 ... -12V = 0 ... -375V if converter is stand-alone (EQ100 X1 not connected)
if in normal operation: E_PO + E_NG >> 445VDC = 10V measuring input EZ130 X1:A5 - X1:C5

---

E_NG_CV2
E value converter DC supply negative
converter 2 (rear 65/80kW): E2Q100X1:5-EZX34:5-EZ130X1:C26
no input to EZ130 release 2 generators
release 3 generators only with 2 converters
0 ... -12V = 0 ... -375V if converter is stand-alone (E2Q100 X1 not connected)
if in normal operation: E_PO + E_NG >> 445VDC = 10V measuring input EZ130 X1:A26 - X1:C26

---

E_PO_CV1
E value converter DC supply positive
converter 1: EQ100X1:18-EZX24:18-EZ130X1:A5
0 ... +12V = 0 ... +375V if converter is stand-alone (EQ100 X1 not connected)
if in normal operation: E_PO + E_NG >> 445VDC = 10V measuring input EZ130 X1:A5 - X1:C5

---

E_PO_CV2
E value converter DC supply positive
converter 2: E2Q100X1:18-EZX34:18-EZ130X1:A26
no input to EZ130 version 4512 108 08661..4 release 2 generators
release 3 generators only with 2 converters EZ130 version 4512 108 09102 ... 4
0 ... +12V = 0 ... +375V if converter is stand-alone (E2Q100 X1 not connected)
if in normal operation: E_PO + E_NG >> 445VDC = 10V measuring input EZ130 X1:A26 - X1:C26

---

EN_X/
enable X–ray, system level
preparation or fluoro request, only valid in combination with CAN message (RAD-R/F)
or hardware requests (Optimus C)
EZ139X1:C2-EZX10:1/3-EZX23:15-EZX45:11-EZX46:11-C300X1:11-EWAX51:11-EWAX52:11
-EWA100X2:C26-EWBX51:11-EWBX52:11-EWB100X2:C26
measuring point: EZX82, EZ139X9
part of: signal bus
0V/+15V low active

---


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EX_CD
exposure end signal
contact to drive e.g. an external buzzer
partner of COM_EX_CD

---

EN_X_C/
enable X–ray, internal generator signal
preparation or fluoro request if confirmed by CAN message (RAD–R/F)
or hardware requests (Optimus C)
EZ119X2:C7–EZ130X1:C7–EZ130X2:C7–EZ139X2:C7–EZ150X2:C7–EZX52:9–EZX76
0V/+5V low active
measuring point EZX76
driven by CU if EN_X/ active (low)
part of: XS/XRG bus

---

EX_ON
exposure on
EWA100X2:A9–EWAX14:7
EWB100X2:A9–EWBX14:7
potential free optocoupler driven signal
in combination with IT_0V
supply: max 26V 10mA
part of: EXON old world

---

FD_C_CH1
central field measuring chamber 1
EZ150X1:C4–EZX21:12
+15V, Ri of EZ150 = 220Ω

---

FD_C_CH2
central field measuring chamber 2
EZ150X1:A4–EZX22:12
+15V, Ri of EZ150 = 220Ω

---

FD_C_CH3
central field measuring chamber 3
EZ150X1:C10–EZX31:12
+15V, Ri of EZ150 = 220Ω

---

FD_C_CH4
central field measuring chamber 4
EZ150X1:A10–EZX32:12
+15V, Ri of EZ150 = 220Ω

---

FD_C_CH5
central field measuring chamber 5
EZ150X1:C16–EZX41:12
+15V, Ri of EZ150 = 220Ω

---


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FD_L_CH1
left field measuring chamber 1
EZ150X1:C3-EZX21:11
+15V, Ri of EZ150 = 220Ω

FD_L_CH2
left field measuring chamber 2
EZ150X1:A3-EZX22:11
+15V, Ri of EZ150 = 220Ω

FD_L_CH3
left field measuring chamber 3
EZ150X1:C9-EZX31:11
+15V, Ri of EZ150 = 220Ω

FD_L_CH4
left field measuring chamber 4
EZ150X1:A9-EZX32:11
+15V, Ri of EZ150 = 220Ω

FD_L_CH5
left field measuring chamber 5
EZ150X1:C15-EZX41:11
+15V, Ri of EZ150 = 220Ω

FD_R_CH1
right field measuring chamber 1
EZ150X1:C5-EZX21:3
+15V, Ri of EZ150 = 220Ω

FD_R_CH2
right field measuring chamber 2
EZ150X1:A5-EZX22:3
+15V, Ri of EZ150 = 220Ω

FD_R_CH3
right field measuring chamber 3
EZ150X1:C11-EZX31:3
+15V, Ri of EZ150 = 220Ω

FD_R_CH4
right field measuring chamber 4
EZ150X1:A11-EZX32:3
+15V, Ri of EZ150 = 220Ω
FD_R_CH5
right field measuring chamber 5
EZ150X1:C17-EZX41:3
+15V, Ri of EZ150 = 220Ω


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FI_TF1_1
filament transformer 1 line 1
EZ119X1:DBZ4-EZX12:1-EG106X15:1
square pulses 100 ... 20kHz, amplitude ~ 300V

---

FI_TF1_2
filament transformer 1 line 2
EZ119X1:DBZ6-EZX12:2-EG106X15:2
square pulses 100 ... 20kHz, amplitude ~ 300V

---

FI_TF2_1
filament transformer 2 line 1
EZ119X1:DBZ8-EZX12:4-EG106X15:4
square pulses 100 ... 20kHz, amplitude ~ 300V

---

FI_TF2_2
filament transformer 2 line 2
EZ119X1:DBZ10-EZX12:5-EG106X15:5
square pulses 100 ... 20kHz, amplitude ~ 300V

---

GND
ground
-EZ102X1:DBZ6-EZ119X1:DBZ26-EZ102X2:DBZ8/10/12/14/16/18/20/26/30-EZ119X2:AC4/5/13/15/16/32
-EZ130X2:C16:AC4/5/13/15/32-EZ139X2:AC4/5/13/15/32-EZ150X2:AC4/5/13/15/32-EZX21:13
-EZX22:13-EZX31:13-EZX32:13-EZX41:13-EZX12:3/6-EZX51:11/12/13/14/15-EZX151:X11/12/13/14/15
-EZX44:1/7-EZX46:8/13-EZX1:9-EZX2:10-EZX3:10-EZX5-EZX6-EZX7:3-EZX8:3-EZX17:2-EZX18:2
-EZX19:2-EZX20:2
-EWGX11:4-EWGX12:4-EWGX1:9-EWGX2:9-EWGX3:9-EWGX4:10-EWGX5:10
-EWGX6:10-EWGX7:10-EWGX8:10-EWGX9:10
-EWAX41:2-EWAX42:2-EWAX51:15-EWAX52:15
-EWAX1:7-EWAX2:7-EWAX3:7-EWAX4:7-EWAX11:2-EWAX11:4-EWAX11:6-EWAX11:9-EWAX12:2
-EWAX12:4-EWAX12:6-EWAX12:9-EWAX13:9-EWAX14:9-EWAX21:10-EWAX23:10-EWAX24:1
-EWAX24:10
-WA102X1AC2-WA102X2:AC15/28
-EWBX41:2-EWBX42:2-EWBX51:15-EWBX52:15-EWBX1:7-EWBX2:7-EWBX3:7-EWB4:7
-EWBX11:2-EWBX11:9-EWBX12:10-EWBX13:4-EWBX13:6-EWBX21:6-EWBX22:10-EWBX23:10
-EWBX24:1-EWBX24:10
-WB102X1AC2-WB102X2:AC15/28
-EYAX1:15/16/17-EYAX2:1-EY100X1:11/12/13/14/15-EY100X13-EY100X41
-C200X1:2-C200X2:17/18/19/20-X100X1:17/18/19/20-C100X10-C100X2:6/7/8/9/10-C300X4:6/7/8/9/10
-C300X2:1/5
-EZX87 (cannot be used as signal ground at DuoDiagnost, only Optimus RAD-R/F)

---

GND_15V
ground (+15V) for desk hand switch
C300X3:1/2/6

---


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HT_AN
high tension anode side actual value
EG100X14:2-EZX35:2-EZ130X1:C17
0 ... +10V = 0 ... +100 kV measured at 10kOhm (20kΩ measuring circuit parallel to 20kΩ kV_control)

---

HT_AN_GND
high tension anode side ground
EG100X14:10-EZX35:10-EZ130X1:A17
0V

---

HT_CA
high tension cathode side actual value
EG100X14:1-EZX35:1-EZ130X1:C16
0 ... -10V = 0 ... -100kV measured at 10kOhm (20kΩ measuring circuit parallel to 20kΩ kV_control)

---

HT_CA_GND
high tension cathode side ground
EG100X14:9-EZX35:9-EZ130X1:A16
0V

---

I1_1
partner of I1_1/ optocoupler signal IGBT1 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 ***** release 2
EQ100 ≥ 4512 108 09341 ***** release 3
EZ130X1:A1-EZX24:14-EQ100X1:14
measuring point: EQ100 R25 end to X1 ***** EQ100 X6
value: on = 3.7V off = 1.2V against ground ***** = X10

---

I1_1/
partner of I1_1 optocoupler signal IGBT1 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 ***** release 2
EQ100 ≥ 4512 108 09341 ***** release 3
EZ130X1:C1-EZX24:1-EQ100X1:1

---


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I1_2
partner of I1_2/ optocoupler signal IGBT2 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A2-EZX24:15-EQ100X1:15

---

I1_2/
partner of I1_2 optocoupler signal IGBT2 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C2-EZX24:2-EQ100X1:2
measuring point: EQ100 R27 end to X1 * EQ100 X7
value: ON = 3.7V OFF = 1.2V against ground * = X10

---

I1_3
partner of I1_3/ optocoupler signal IGBT3 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A3-EZX24:16-EQ100X1:16

---

I1_3/
partner of I1_3 optocoupler signal IGBT3 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C3-EZX24:3-EQ100X1:3
measuring point: EQ100 R29 end to X1 * EQ100 X8
value: ON = 3.7V OFF = 1.2V against ground * = X10

---

I1_4
partner of I1_4/ optocoupler signal IGBT4 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A4-EZX24:17-EQ100X1:17

---

I1_4/
partner of I1_4 optocoupler signal IGBT4 power part 1
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C4-EZX24:4-EQ100X1:4
measuring point: EQ100 R31 end to X1 * EQ100 X9
value: ON = 3.7V OFF = 1.2V against ground * = X10

---


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I2_1
partner of I2_1/ optocoupler signal IGBT1 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A22-EZX34:14-E2Q100X1:14

---

I2_1/
partner of I2_1 optocoupler signal IGBT1 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C22-EZX34:1-E2Q100X1:1
measuring point: EQ100 R25 end to X1 * E2Q100 X6
value: ON = 3.7V OFF = 1.2V against ground * = X10

---

I2_2
partner of I2_2/ optocoupler signal IGBT2 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A23-EZX34:15-E2Q100X1:15

---

I2_2/
partner of I2_2 optocoupler signal IGBT2 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C23-EZX34:2-E2Q100X1:2
measuring point: EQ100 R27 end to X1 * E2Q100 X7
value: ON = 3.7V OFF = 1.2V against ground * = X10

---

I2_3
partner of I2_3/ optocoupler signal IGBT3 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A24-EZX34:16-E2Q100X1:16

---

I2_3/
partner of I2_3 optocoupler signal IGBT3 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C24-EZX34:3-E2Q100X1:3
measuring point: EQ100 R29 end to X1 * E2Q100 X8
value: ON = 3.7V OFF = 1.2V against ground * = X10

---


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I2_4
partner of I2_4/ optocoupler signal IGBT4 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:A25-EZX34:17-E2Q100X1:17

---

I2_4/
partner of I2_4 optocoupler signal IGBT4 power part 2
EQ100 = 4512 108 05882 release 2
EQ100 ≥ 4512 108 08621 * release 2
EQ100 ≥ 4512 108 09341 * release 3
EZ130X1:C25-EZX34:4-E2Q100X1:4
measuring point: EQ100 R31 end to X1 * E2Q100 X9
value: ON = 3.7V OFF = 1.2V against ground * = X10

---

IT_0V
emitter 0V exposure on signal
EWA100X2:C9-EWAX14:9
EWB100X2:C9-EWBX14:9
potential free optocoupler driven signal
in combination with EX_ON
part of: EXON old world

---

Iu
stator current phase U of low speed rotor control
measuring point EYAX22
10A/V

---

Iw
stator current phase W of low speed rotor control
measuring point EYAX21
10A/V

---

MN_EM_OF
mains power emergency off
EZX4:1-EZX47:6-EN100X1:6

---

MN_ON
mains on
C300X1:6-EZX46:6-EZX47:2-EN100X1:2-EZX44:14 Optimus RAD – R/F
CB100X10:3-EZX46:6-EZX47:2-EN100X1:2-EZX44:14 Optimus C

---

NG_15V
-15V supply Vee
EZ102X2:DBZ24-EZ119X2:AC12-EZ130X2:AC12-EZ139X2:AC12-EZ150X2:AC12-EZX21:6-EZX22:6
-EZX31:6-EZX32:6-EZX41:6-EZX35:15-EZX51:8-EZX151:8-EG100X14:15
-14.5V ... -15.5V

---


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NR_PR_X/
not ready preparing for X–ray
EZ139X1:A3–EZX23:3–EZX45:4–EZX46:4–C300X1:4–EWAX51:4–EWAX52:4–EWA100X2:A24–EWBX51:4
–EWBX52:4–EWB100X2:A24
driven by CU and/or system controller
measuring point: EZX83
part of: signal bus
0V/+15V high active

---

PO_0V
signal bus ground GNDS
EZ139X1:AC1–EZX23:1/14–EZX44:15–EZX45:15–EWAX51:15–EWAX52:15–EWBX51:15–EWBX52:15
part of: signal bus, supply via X44 Optimus RAD+R/F, from Cockpit at DuoDiagnost systems

---

PO_12V
+12 V supply
EN100X1:1–EZX47:1–EZX46:7–C300X1:7

---

PO_15V
+15V supply Vdd
EZ102X2:DBZ22–EZ119X2:AC11–EZ130X2:AC11–EZ139X2:AC11
–EZ150X2:AC11–EZX2:8/9–EZX35:7–EZX44:12/13–EZX46:5
–EZX51:7–EG100X14:7–C300X1:5
–EZX21/22/31/32/41:5 backpanel 4512 108 05983 only
–EZX151:7 backpanels 4512 108 05984 + 4512 108 09361/2 only
+14.5V ... +15.5V

---

PO_15/40V
+15V or +40V supply for measuring chamber
EZ150X1:A20–EZX21/22/31/32/41:5EZ150 version ≥ 4512 108 05964
EZX21/22/31/32/41:5 via (15/40V Sub–D/3+ adapter) EZX21/22/31/32/41:L EZ150 version 4512 108 05963

---

PO_26V
+26V supply
EZ102X2:DBZ28–EZ119X2:AC14–EZ130X2:AC14–EZ139X2:AC14–EZ150X2:AC14–EZX1:5–EZX2:3
–EZX3:9–EZX11:1–EWGX11:1–EWGX12:1–EZX17:1–EZX18:1–EQ100X2:1–E2Q100X2:1

---

PO_26V_1
+26V supply options
EZ102X2:DBZ32–EZX19:1–EZX20:1–
–EWAX1:4–EWAX2:4–EWAX3:4–EWAX4:4–EWAX41:1–EWAX42:1–EWAX23:9–EWAX24:5
–EWA100X2:AC14–EWBX1:4–EWBW2:4–EWBX3:4–EWBX4:4–EWBX41:1–EWAX42:1–EWBX21:9
–EWBX22:9– EWBX23:9–EWBX24:5–EWB100X2:AC14
–EZX8:1 backpanels 4512 108 05984 + 4512 108 09361/2

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PO_26V_RE
+26V reverse supply
EWAW11-EWAW12-EWAX1/2/3/4:4-EWAX42:1
if generator and system release voltages do not match
normal condition: PO_26V_RE = +26V of generator against ground
(jumper WA W11 + W13 closed, W12 open)
special condition: PO_26V_RE = 0V against -24V, supply from stand
(jumper WA W11 + W13 open, W12 closed)

---

PO_26V_SW
+26V supply switched, for cooling fan low voltage power supply
EZ102X1:D32-EZX7:1-EM1 backpanels 4512 108 05984 + 4512 108 09361/2

---

PO_40V
+15V or + 40V supply for measuring chamber
EZ150X1:A20-EZX21/22/31/32/41:5 EZ150 version ≥ 4512 108 05964
EZX21/22/31/32/41:5 via (15/40V Sub-D/3+ adapter) EZX21/22/31/32/41:L EZ150 version 4512 108 05963

---

PO_400V
+400V supply measuring chamber
EZ150X1:AC1-EZX21/22/31/32/41:1
+400V, Ri of EZ150 = 100kOhms

---

PO_5V
+5V supply Vcc
EZ102X2:DBZ2/4/6-EZ119X2:AC1/2-EZ130X2:AC1/2-EZ139X2:AC1/2-EZ150X2:AC1/2-EZX46:9-C300X1:9
-EZX51:4/5/6-EZX151:4/5/6
+4.74V ... +5.25V

---

PO_V
signal bus supply
EZX23:13/25-EZX44:5-EZX45:7-EZ139X1:AC6
(V15S = -EWAX51:7-EWAX52:7-EWA100X2:AC27-EWBX51:7-EWBX52:7-EWB100X2:AC27)
+15V Vsgn, supply via X44 Optimus RAD+R/F, from Cockpit at DuoDiagnost systems part of signal bus

---

POWERFAIL/
power fail signal of low voltage power supply, initiates warm-boot if supply voltage phase L1 drops below 196VAC
EZ102X1:D30-EZ139X1:A10

---

PW_ON_NG
relay power on negative, energizes ENK1 if generator ready
EZ130X1:A15-EZX47:9-EN100X1:9
partner of PW_ON_PO
0V/+15V (pulled up by relay coil EN100 K2), low active

---


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PW_ON_PO
supply relay power on positive,
EZ130X1:C15–EZX47:4–EN100X1:4
partner of PW_ON_NG
+15V

RC_ON/
rotor control on, low speed rotor control only

| | | |
|---|---|---|
| EZ150X1:A25–EZX51:1 | backpanel | 4512 108 05983 |
| EZ150X1:A25–EZX51:1–EZX151:1 | backpanels | 4512 108 05984 + 4512 108 09361/2 |

measuring point EYAX28

RC_RD/
rotor control ready, low speed rotor control only

| | | |
|---|---|---|
| EYAX1:9–EXZ51:9–EZ150X1:C25 | backpanel | 4512 108 05983 |
| EYAX1:9–EXZ51:9–EZX151:9–EZ150X1:C25 | backpanels | 4512 108 05984 + 4512 108 09361/2 |

measuring point EYAX25

RC_ST_2/
rotor control stator 2

| | |
|---|---|
| EZ150X1:A26–EZX16:1–EWGX14:1 | low speed rotor control |
| EY100X3:1–EWGX14:1 | high speed rotor control |

RC_ST_3/
rotor control stator 3

| | |
|---|---|
| EZ150X1:C26–EZX16:2–EWGX14:2–EWGX15:1 | low speed rotor control |
| EY100X3:2–EWGX14:2–EWGX15:1 | high speed rotor control |

RD_MN_ON
ready mains power on

| | |
|---|---|
| C100X2:50–C300X4:50–C300X1:14–EZX46:14–EZX47:7–EN100X1:7 | Optimus RAD – R/F |
| CB100X10:4– EZX46:14–EZX47:7–EN100X1:7 | Optimus C |

RD_PR_X
NR_PR_X/
ReaDy preparing for X–ray or Not Ready preparing for X–ray
EZ139X1:A3–EZX23:3–EZX45:4–EZX46:4–C300X1:4– –EWAX51:4–EWAX52:4–EWA100X2:A24
driven by CU or other system components
measuring point: EZX83
part of: signal bus
0V/+15V high active signal

REL_CH1
release (reset integrator) chamber 1
EZ150X1:C6–EZX21:4
0V/+15V, typically +13V, high active


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REL_CH2
release (reset integrator) chamber 2
EZ150X1:A6-EZX22:4
0V/+15V, typically +13V, high active

---

REL_CH3
release (reset integrator) chamber 3
EZ150X1:C12-EZX31:4
0V/+15V, typically +13V, high active

---

REL_CH4
release (reset integrator) chamber 4
EZ150X1:A12-EZX32:4
0V/+15V, typically +13V, high active

---

REL_CH5
release (reset integrator) chamber 5
also used as EXON signal for DSI
EZ150X1:C18-EZX41:4
0V/+15V, typically +13V, high active

---

RESET_1
external reset
resets incorrect, exposure indication, 5min fluoro buzzer, errors
EWBX22:7-EWB100X1:C23
0V/+26V low active

---

RESET_C/
internal RESET command for function units
EZ119X2:A6- EZ130X2:A6-EZ139X2:A6-EZ150X2:A6-EZX52:3-EZX45:3-EZX46:3-C300X1:3
-EZX51:10-EZX73-EWAX51:3-EWAX52:3-EWA100X1:A6-EWBX51:3-EWBX52:3-EWB100X1:A6-
-EZX151:10 backpanels 4512 108 05984 + 4512 108 09361/2
0V/+5V
measuring point EZX73
driven by CU, active (low) if: EZ139 S1 activated, RESET_SW/ ON signal bus active,
threatening power supply drop in, watchdog alarm, switch ON or warm-start,
resets FU's
part of: XS/XRG bus

---

RESET_SW/
signal bus reset, generator reset with turn ON or push of turn ON button as warm-start
EZX23:2-EZX44:6-EZ139X1:A2
0V/+15V low active
time constant ≥ 200ms
resets CU only
measuring point: EZX81
part of: signal bus

---


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RF_0V_CH1
0V reference value measuring chamber 1
EZX21:8-EZ150X1:C8
differential signal with SIGN_CH1

RF_0V_CH2
0V reference value measuring chamber 2
EZX22:8-EZ150X1:A8
differential signal with SIGN_CH2

RF_0V_CH3
0V reference value measuring chamber 3
EZX31:8-EZ150X1:C14
differential signal with SIGN_CH3

RF_0V_CH4
0V reference value measuring chamber 4
EZX32:8-EZ150X1:A14
differential signal with SIGN_CH4

RF_0V_CH5
0V reference value measuring chamber 5
EZX41:8-EZ150X1:C20
differential signal with SIGN_CH5

RG_DV_1
registration device 1 selected
EWA100X1:C4-EWAX1:5
EWB100X1:C4-EWBX1:5

RG_DV_2
registration device 2 selected
EWA100X1:A7-EWAX2:5
EWB100X1:A7-EWBX2:5

RG_DV_3
registration device 3 selected
EWA100X1:A9-EWAX3:5
EWB100X1:A9-EWBX3:5

RG_DV_4
registration device 4 selected
EWA100X1:A11-EWAX4:5
EWB100X1:A11-EWBX4:5


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RG_DV_SL_1
registration device selection 1
cassette / camera switchover signal
EWBX21:1-EWB100X1:C18
0V/+26V low active
partner of RG_DV_SL_2, only one of these should be low active at a time

---

RG_DV_SL_2
registration device selection 2
camera / cassette switchover signal
EWBX21:2-EWB100X1:A19
0V/+26V low active
partner of RG_DV_SL_1, only one of these should be low active at a time

---

RM_DR_0V
room door contact 0V
EZ150X1:C28-EZX1:10-EWGX1:10-EWGX2:10-EWGX3:10
release 2 generators only, not used release 3 RAD-R/F and Optimus C
partner of RM_DR_CT signal release 2 RAD generators only
0V/+26V low active, detects room door contact signal short circuit at release 2 RAD generators during turn ON

---

RM_DR_CT
room door contact
EZ150X1:A28-EZX1:8-EWGX1:8=EWGX2:8=EWGX3:8 backpanels 4512 108 05983/4
EZ150X1:A28-EZX45:8-EWBX51:8-EWBX52:8-EWBX22:8-EZX1:8-EWGX1:8=EWGX2:8=EWGX3:8
backpanels 4512 108 09361/2
partner of RM_DR_0V signal release 2 RAD generators only
0V/+26V low active = door closed

---

RQ_M1_X/
request mode 1 (fluoro)
Optimus C only, not used
EZX23:9-EZ139X1:C4

---

RQ_M2_X/
request mode 2 (exposure)
Optimus C only, not used
EZX23:22-EZ139X1:C5

---

RQ_M3_X/
request mode 3
Optimus C only, not used
EZX23:10-EZ139X1:C7

---


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RQ_SN_X/
request synchronization of X-ray, exposure request signal
EZX23:16-EZX45:12-EZX46:12-C300X1:12-EZ139X1:C3-EWAX51:12-EWAX52:12-EWA100X2:A25
-EWBX51:12-EWBX52:12-EWB100X2:A25
measuring point: EZX84
0V/+15V
part of: signal bus

---

RQ_XG_EX
request X–ray generator for exposure
EWAX1:1- EWAX1:2- EWAX1:3- EWAX1:4-EWA100X1:A3
EWBX1:1- EWBX1:2- EWBX1:3- EWBX1:4-EWB100X1:A3
0V/+26V low active, high if waiting for sync contact
partner of XG_RD_EX for grid sync (20-21)

---

RQ_XG_FL
request X–ray generator for fluoroscopy
EWAX1:6-EWAX2:6-EWAX3:6-EWAX4:6-EWA100X1:A5 not possible with WA
EWBX1:6-EWBX2:6-EWBX3:6-EWBX4:6-EWB100X1:A5
0V/+26V low active

---

RQ_XG_PR_1
request X–ray generator for preparation
EWAX1:3-EWA100X1:A4
EWBX1:3-EWB100X1:A4
0V/+26V low active

---

RQ_XG_PR_2
request X–ray generator for preparation
EWAX2:3-EWA100X1:C6
EWBX2:3-EWB100X1:C6
0V/+26V low active

---

RQ_XG_PR_3
request X–ray generator for preparation
EWAX3:3-EWA100X1:C8
EWBX3:3-EWB100X1:C8
0V/+26V low active

---

RQ_XG_PR_4
request X–ray generator for preparation
EWAX4:3-EWA100X1:C10
EWBX4:3-EWB100X1:C10
0V/+26V low active

---

RX_CAN_1
system CAN 1 optional
EZX44:3-EZ139X1:C15

---


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RX_CAN_2
system CAN 2 optional
EZX43:1-EZX44:11

---

S_CAN_GND
system CAN bus ground
EZ139X1:C17-EZX42:3/6-EZX43:3/6-EZX44:9
-(EZX44:9- EZX44:1- to GND via function programming plug 4512 130 54441 Optimus RAD only)
part of: system CAN

---

S_CAN_L
system CAN low active
EZ139X1:C16-EZX42:2-EZX43:2
+2.5VDC standby, +1.5VDC during communication
part of: system CAN

---

S_CAN_H
system CAN high active
EZ139X1:A16-EZX42:7-EZX43:7
+2.5VDC standby, +3.2VDC during communication
part of: system CAN

---

S_CAN_PO
system CAN supply
EZX44:4-EZX42:9-EZX43:9-EZ139X1:A17
-(EZX44:12-EZX44:9 supply via function programming plug 4512 130 54441 Optimus RAD only)
typically +12V, Vcan
part of: system CAN

---

SI_PH/
single phase identifier
EN100X1:5-EZX47:5-EZ130X1:C14

---

SI_PH_ID
single phase identifier
EN100X1:5-EZX47:5-EZ130X1:C14

---

SIGN_CH1
dose signal of measuring chamber 1
EZX21:7-EZ150X1:C7
0 ... 12V (24V out of range possible)
differential signal with RF_0V_CH1

---

SIGN_CH2
dose signal of measuring chamber 2
EZX22:7-EZ150X1:A7
0 ... 12V (24V out of range possible)
differential signal with RF_0V_CH2

---


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SIGN_CH3
dose signal of measuring chamber 3
EZX31:7-EZ150X1:C13
0 ... 12V (24V out of range possible)
differential signal with RF_0V_CH3

SIGN_CH4
dose signal of measuring chamber 4
EZX32:7-EZ150X1:A13
0 ... 12V (24V out of range possible)
differential signal with RF_0V_CH4

SIGN_CH5
dose signal of measuring chamber 5
EZX41:7-EZ150X1:C19
0 ... 12V (24V out of range possible)
differential signal with RF_0V_CH5

SL_CO_1
select correction 1
external patients size correction, slim patient
EWA100X1:A32-EWAX24:8
EWB100X1:A32-EWBX24:8
0V/+26V low active for selection or when selected from generator desk

SL_CO_2
select correction 2
external patients size correction, stout patient
EWA100X1:C32-EWAX24:9
EWB100X1:C32-EWBX24:9
0V/+26V low active for selection or when selected from generator desk

SL_PG_1
select external APRT program 1
EWA100X1:A28-EWAX23:1
EWB100X1:A28-EWBX23:1
0V/+26V low active for selection or when selected from generator desk

SL_PG_2
select external APRT program 2
EWA100X1:C28-EWAX23:2
EWB100X1:C28-EWBX23:2
0V/+26V low active for selection or when selected from generator desk

SL_PG_3
select external APRT program 3
EWA100X1:A29-EWAX23:3
EWB100X1:A29-EWBX23:3
0V/+26V low active for selection or when selected from generator desk


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SL_PG_4
select external APRT program 4
EWA100X1:C29–EWAX23:4
EWB100X1:C29–EWBX23:4
0V/+26V low active for selection or when selected from generator desk

SL_PG_5
select external APRT program 5
EWA100X1:A30–EWAX23:5
EWB100X1:A30–EWBX23:5
0V/+26V low active for selection or when selected from generator desk

SL_PG_6
select external APRT program 6
EWA100X1:C30–EWAX23:6
EWB100X1:C30–EWBX23:6
0V/+26V low active for selection or when selected from generator desk

SL_PG_7
select external APRT program 7
EWA100X1:A31–EWAX23:7
EWB100X1:A31–EWBX23:7
0V/+26V low active for selection or when selected from generator desk

SL_PG_8
select external APRT program 8
EWA100X1:C31–EWAX23:8
EWB100X1:C31–EWBX23:8
0V/+26V low active for selection or when selected from generator desk

SL_TO_TM_1
select tomo time 1
tomo time input from stand
EWAX21:1–EWA100X1:A24
0V/+26V low active

SL_TO_TM_2
select tomo time 2
tomo time input from stand
EWAX21:2–EWA100X1:C24
0V/+26V low active

SL_TO_TM_3
select tomo time 3
tomo time input from stand
EWAX21:3–EWA100X1:A25
0V/+26V low active


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SL_TO_TM_4
select tomo time 4
tomo time input from stand
EWAX21:4–EWA100X1:C25
0V/+26V low active

---

SL_TO_TM_5
select tomo time 5
tomo time input from stand
EWAX21:5–EWA100X1:A26
0V/+26V low active

---

SL_TO_TM_6
select tomo time 6
tomo time input from stand
EWAX21:6–EWA100X1:C26
0V/+26V low active

---

SL_TO_TM_7
select tomo time 7
tomo time input from stand
EWAX21:7–EWA100X1:A27
0V/+26V low active

---

SL_TO_TM_8
select tomo time 8
tomo time input from stand
EWAX21:8–EWA100X1:C27
0V/+26V low active

---

SL_XG_TO
select X–ray generator for tomography
EWAX11:3–EWAX12:3–EWA100X1:C18
0V/+26V, low active

---

STOP_X_C/
stop X–ray command, X–ray OFF from function units mA and dose rate control (on–board of CU)
EZ119X2:A7–EZ130X2:A7– EZ139X2:A7–EZ150X2:A7–EZX52:4
0V/5V
measuring point EZX75
inactivates CTRL_X_C/
EXOF exposure OFF command
part of: XS/XRG bus

---


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STU
stator phase U
EYAX2:2-EX1101 low speed rotor control single tube

| | |
|---|---|
| EYAX2:2-EWGK11:1-EWGK12:1=EWGK11:2=EWGK12:2 | low speed two tubes |
| EY100X46:2-EX1101 | high speed rotor control vers. 4512 104 33791/2 or 71401..6 single tube |
| EY100X46:2-EWGK11:1-EWGK12:1=EWGK11:2=EWGK12:2 | high speed rotor control vers. 4512 104 33791/2 or 71401..6 two tubes |
| EY100X51-EX1101 | high speed rotor control vers. 4512 104 71421/61 single tube |
| EY100X51--EWGK11:1-EWGK12:1=EWGK11:2=EWGK12:2 | high speed rotor control vers. 4512 104 71421/61 two tubes |

STV
stator phase V = common

| | |
|---|---|
| EYAX2:3-EX1102 | low speed rotor control single tube |
| EYAX2:3-EWGK11:3-EWGK12:3=EWGK11:4=EWGK12:4 | low speed two tubes |
| EY100X47:1-EX1102 | high speed rotor control vers. 4512 104 33791/2 or 71401..6 single tube |
| EY100X47:1-EWGK11:3-EWGK12:3=EWGK11:4=EWGK12:4 | high speed rotor control vers. 4512 104 33791/2 or 71401..6 two tubes |
| EY100X52-EX1102 | high speed rotor control vers. 4512 104 71421/61 single tube |
| EY100X52--EWGK11:3-EWGK12:3=EWGK11:4=EWGK12:4 | high speed rotor control vers. 4512 104 71421/61 two tubes |

STW
stator phase W

| | |
|---|---|
| EYAX2:4-EX1103 | low speed rotor control single tube |
| EYAX2:4-EWGK11:5-EWGK12:5=EWGK11:6=EWGK12:6 | low speed two tubes |
| EY100X47:2-EX1103 | high speed rotor control vers: 4512 104 33791/2 or 71401..6 single tube |
| EY100X47:2-EWGK11:5-EWGK12:5=EWGK11:6=EWGK12:6 | high speed rotor control vers. 4512 104 33791/2 or 71401..6 two tubes |
| EY100X53-EX1103 | high speed rotor control vers. 4512 104 71421/61 single tube |
| EY100X53--EWGK11:5-EWGK12:5=EWGK11:6=EWGK12:6 | high speed rotor control vers. 4512 104 71421/61 two tubes |

SW_BU_1
switch bucky 1 ready (WA + WB)
EWAX11:10-EWA100X1:C19
EWBX11:10-EWB100X1:C19
part of: bucky ready contact
0V/+26V low active

SW_BU_2
switch bucky 2 ready (WA only)
EWAX12:10-EWA100X1:A21
part of: bucky ready contact
0V/+26V low active


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SW_OF_FD_1
switch OFF field 1
format size correction < 14cm or if cone in use serial changer chamber
EWBX13:5-EWB100X1:C21
0V/+26V low active

---

SW_ON_FD_3
switch ON field 3
format size correction > 24x24cm serial changer chamber
EWBX13:7-EWB100X1:A22
0V/+26V low active

---

SW_PR_FL_1
switch preparation or fluoro 1
contact to drive an external prep or fluoro indication lamp
EWBX22:2-EWB100X1:C13
partner of COM_EX_CD

---

SW_SF_CF_1
switch side field to central field bucky measuring chamber (WA + WB)
EWAX11:1-EWA100X1:A18
EWBX11:1-EWB100X1:A18
cassettes < 23cm
0V/+26V low active

---

SW_SF_CF_2
switch side field to central field bucky measuring chamber 2 (WA only)
EWAX12:1-EWA100X1:A20
cassettes < 23cm
0V/+26V low active

---

SW_TO_1
switch tomography 1 ready
EWAX11:5-EWA100X1:A19
part of: tomo ready contact
0V/+26V low active

---

SW_TO_2
switch tomography 2 ready
EWAX12:5-EWA100X1:C20
part of: tomo ready contact
0V/+26V low active

---

SW_UN_EX
radiation indication
EZ150X1:A29-EZX1:4-EWGX1:4
partner of CM_SW, potential free contact

---


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SW_UN_EX_1
radiation indication
(EWGX1:4)=EWGX2:4
partner of CM_SW, potential free contact

---

SW_UN_EX_1
switch radiation indication 1
contact to drive an external X-ray indication lamp
EWBX22:4-EWB100X1:C14
partner of COM_EX_CD

---

SW_UN_EX_2
radiation indication
(EWGX1:4)=EWGX3:4
partner of CM_SW, potential free contact

---

SW_XG_RD_1
switch generator ready 1
contact to drive an external ready indication lamp
EWBX22:1-EWB100X1:A13
partner of COM_EX_CD

---

SW_WN_FL_1
switch warning fluoro 1
contact to drive an external fluoro warning indication lamp (> 5 minutes)
EWBX22:3-EWB100X1:A14
partner of COM_EX_CD

---

TB_2/
tube 2 selected
EZ130X1:A13-EZX11:2-EWGX11:2
0V/15V, low active

---

TB_2_RT
tube 2 return signal, tube selection check
EWGX11:3-EZX11:3-EZ130X1:A10
0V/5V, low active

---

TB_3/
tube 3 selected
EZ130X1:C13-EZX11:5-EWGX11:5-EWGX12:2
0V/15V, low active

---

TB_3_RT
tube 3 return signal, tube selection check
E2WGX11:3-E1WGX12:3-E1WGX11:6-EZX11:6-EZ130X1:C10
0V/5V, low active

---


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TB_CU_FR_NG
tube current frequency negative
EG100X14:14-EZX35:14-EZ119X1:BZ32
-14V against ground, frequency: 1 kHz = 2mA, 0 ... 1500mA 500kHz/A
differential signal with TB_CU_FR_PO

---

TB_CU_FR_PO
tube current frequency positive
EG100X16:6-EZX35:6-EZ119X1:BZ30
-14V against ground, frequency: 1 kHz = 2mA, 0 ... 1500mA 500kHz/A
differential signal with TB_CU_FR_NG

---

TH_OL
tube housing overload
NTC temperature measurement in tube housing (not yet available)
EZ130X1:A12-EZX3:6-EWGX7:6-EWGX8:6-EWGX9:6
backpanel 4512 108 05983
EZ130X1:A12-EZX3:3-EWGX7:3-EWGX8:3-EWGX9:3
backpanels 4512 108 05984 + 4512 108 09361/2
4.4V ... 1.5V = 20 ... 100 degrees C
partner of CM_TH

---

TH_OL_SW/
tube housing overload switch
EZ130X1:A11-EZX3:3-EWGX7:3-EWGX8:3-EWGX9:3
backpanel 4512 108 05983
EZ130X1:A11-EZX3:6-EWGX7:6-EWGX8:6-EWGX9:6
backpanels 4512 108 05984 + 4512 108 09361/2
0V ... 1.7V = short circuit, 1.7V ... 3.3V = closed, >3.3V open
partner of CM_TH_SW

---

TOMO_PG
tomo mode programmed
EWA100X1:A17-EWAX22:9
common line for tomo trajectory selection TO_PG_1 ... 8 to stand, potential free

---

TO_PG_1
tomo program 1
EWA100X1:A13-EWAX22:1
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_2
tomo program 2
EWA100X1:C13-EWAX22:2
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_3
tomo program 3
EWA100X1:A14-EWAX22:3
tomo trajectory selection, potential free contact with TOMO_PG

---


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TO_PG_4
tomo program 4
EWA100X1:C14-EWAX22:4
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_5
tomo program 5
EWA100X1:A15-EWAX22:5
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_6
tomo program 6
EWA100X1:C15-EWAX22:6
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_7
tomo program 7
EWA100X1:A16-EWAX22:7
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_8
tomo program 8
EWA100X1:C16-EWAX22:8
tomo trajectory selection, potential free contact with TOMO_PG

---

TO_PG_SL
tomo program selected
EWA100X1:C17-EWAX22:10
tomo APR selected = closed, overriding = open, potential free contact with TOMO_PG

---

TP_HT_GND
temperature high tension tank ground
EZ130X1:A19-EZX35:12-EG100X14:4
partner of TP_HT_SG

---

TP_HT_SG
temperature signal high tension tank
NTC in high tension tank oil
EG100X14:12-EZX35:4-EZ130X1:C19
4.4V ... 1.5V = 20 ... 100°C
+25 _C(12kW) ... +100 _C(950W)
partner of TP_HT_GND

---

V15C
(S_CAN_PO) backpanel 4512 108 05983 only
system CAN supply
EZX42:9-EZX43:9-EZX44:4-EZ139X1:A17
Vcan
part of: system CAN

---


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V15S
signal bus supply backpanel 4512 108 05983 only
EZX23:13/25-EZX44:5-EZX45:7-EZ130X1:AC6-EWAX51:7-EWAX52:7-EWA100X2:AC27
+15V Vsgn
part of: signal bus

---

VO_CR_IF_0
density voltage correction II format dependent 10”
EWBX13:3-EWB100X1:C22
0V/+26V low active

---

VO_CR_IF_1
density voltage correction II format dependent 5” / 6”
EWBX13:9-EWB100X1:A23

---

X_ACT/
X–ray active signal bus
EZ139X1:A5-EZX23:5-EZX45:6-EWAX51:6-EWAX52:6-EWA100X2:C24-EWBX51:6-EWBX52:6
-EWB100X2:C24
driven by CU if X_ACT_S/ was sent from FU-kV or during fluoro, old: EXON signal
measuring point: EZX86
part of: signal bus
0V/+15V

---

X_ACT_S/
X–ray active signal
kV > 75% nominal value driven by FU-kV or fluoroscopy high tension on driven by CU
EZ119X2:A8-EZ130X2:A8-EZ139X2:A8-EZ150X2:A8-EZX52:5-EZX77
0V/+5V
measuring point EZX77
part of: XS/XRG bus, controls X_ACT/ status

---

XG_RD_EX_1
X–ray generator ready for exposure request
grid / sync release signal
EWA100X1:C3-EWAX1:2
EWAB100X1:C3-EWBX1:2
0V/+26V low active
partner of RQ_XG_EX for grid sync (20-21)

---

XG_RD_EX_2
X–ray generator ready for exposure request
grid / sync release signal
EWA100X1:A6-EWAX2:2
EWB100X1:A6-EWBX2:2
0V/+26V low active
partner of RQ_XG_EX for grid sync (20-21)

---


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XG_RD_EX_3
X–ray generator ready for exposure request
grid / sync release signal
EWA100X1:A8–EWAX3:2
EWB100X1:A8–EWBX3:2
0V/+26V low active
partner of RQ_XG_EX for grid sync (20–21)

XG_RD_EX_4
X–ray generator ready for exposure request
grid / sync release signal
EWA100X1:A10–EWAX4:2
EWB100X1:A10–EWBX4:2
0V/+26V low active
partner of RQ_XG_EX for grid sync (20–21)


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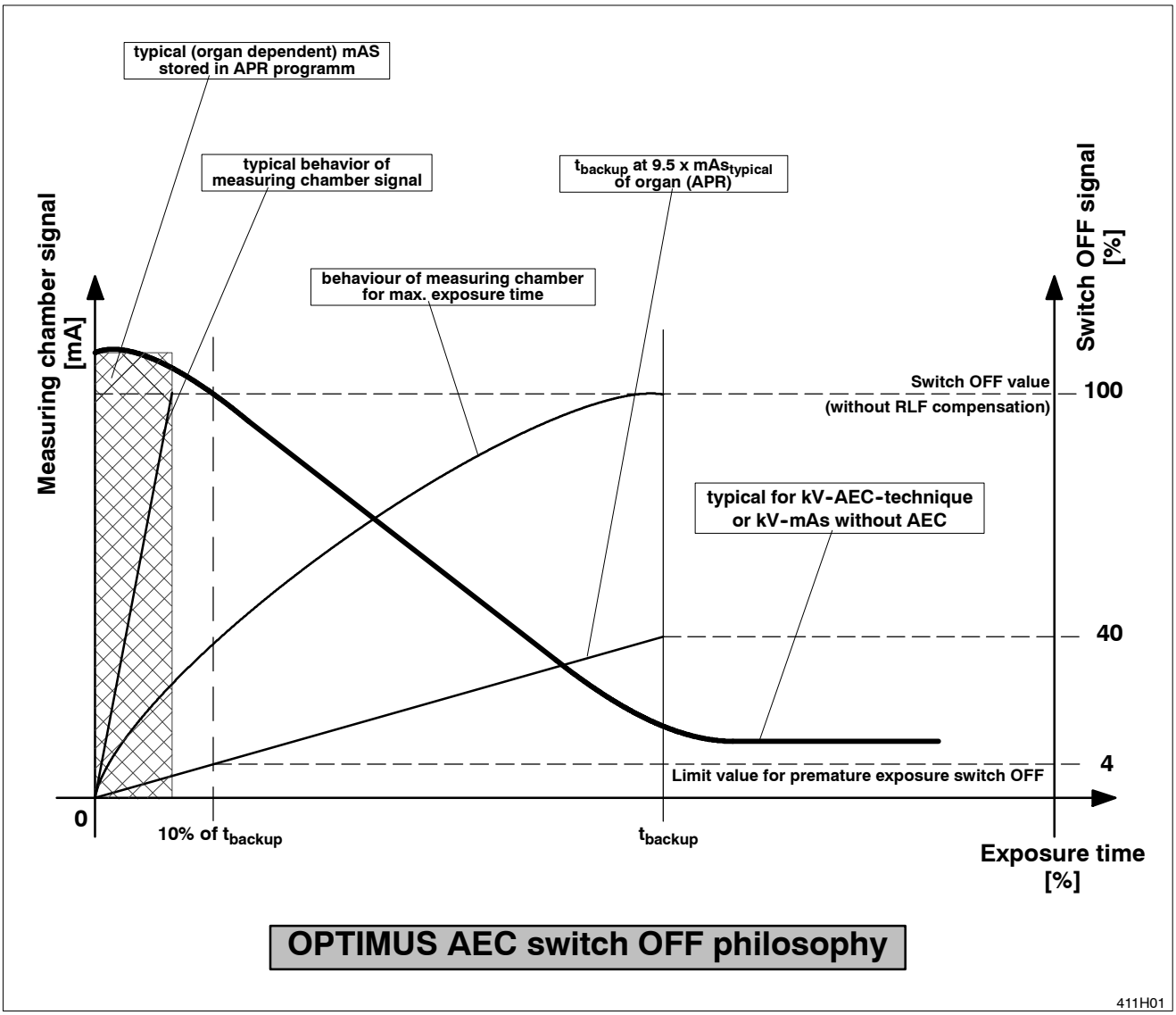
# 13. OPTIMUS AEC switch OFF philosophy

For explanation the following figure:


typical (organ dependent) mAS stored in APR programm
typical behavior of measuring chamber signal
$t_{backup}$ at 9.5 x $mAs_{typical}$ of organ (APR)
behaviour of measuring chamber for max. exposure time
Measuring chamber signal [mA]
Switch OFF signal [%]
Switch OFF value (without RLF compensation)
100
typical for kV-AEC-technique or kV-mAs without AEC
40
4
Limit value for premature exposure switch OFF
0
10% of $t_{backup}$
$t_{backup}$
Exposure time [%]
OPTIMUS AEC switch OFF philosophy
411H01

Every APR using the AEC technique as the preferred technique must have mAs, mA-s or mAs-s parameters in the background. These should almost match the typical organ-related dose to the selected film/screen combination.
A film which got at least 40% of the desired density can be used for diagnosis.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If the AEC exposure starts now two supervisions are active with the aim of not giving unnecessary dose (or simply a proper AEC exposure is obtained):

1. The organ-dependent background mAs value is multiplied with 9.5. If the exposure is not finished at 9.5 x $mAs_{backup}$ the generator stops. One must expect that something went wrong if the exposure exceeded 9.5 times the typical mAs value. This exposure has not been cut OFF by the supervision 2.

2. With the 9.5 x $mAs_{backup}$ a kV and filament load dependent backup time is calculated by DRC (dose rate control). At 10% of this time value DRC checks if at least 4% of the desired dose has been detected by the measuring chamber.
   If the 4% limit does not increase, the exposure switches OFF. The minimum of 40% density cannot be obtained during the remaining backup time.

This 4% dose detection is automatically OFF, if the film/screen combination is too sensitive (> 400 speed systems). The 4% value is too small to be reliable for a measurement.

With overriding the supervision switches OFF.

How to test the limits of 600mAs or 4000ms in AEC technique

One has to bypass the 4% detection and the background mAs value must be high enough to reach 600mAs. The 4% detection can be switched OFF with modifying the value dose of FSC [µGy]:

- Type in a value of 1 (which is equal to a 1000 speed system) in the dose of FSC data field of any of the programmed film/screen combinations.
- Now select any APR and increase the background mAs value to 100mAs.
- Close the collimator or cover the chamber with lead.

The AEC exposure stops at a value which is always below 600mAs, a typical limit is 588mAs.

With the modified parameters the 4000ms test can be carried out:

- Select the modified APR on the control desk and go to <SELECT APR> and <CHANGE APR> with the PC.
- Reduce the Ie max factor to 5% and transmit the APR screen.
- Select the APR button again, the modified data are active now.
- Select the small focal spot.
- Switch an AEC exposure. It should last 4000ms.
- Change all modifications back to normal.

The supervision can be switched ON or OFF, programming path:

XRGSCOPE - Optimus (XRG90) - Programming - Dose Rate Control - AMPLIMAT - Fault Exposure Detection - AEC or TDC - ON/OFF

(Explanation see documentation.)

Precalculation tables of the exposure which is actually displayed on the control desk can be seen on the PC under:

XRGSCOPE - Optimus (XRG90) - Faultfind - X-Ray Log - Dose Rate Control Logging - etc.


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# 14. AEC fault exposure detection strategy

The major intention of having a fault exposure detection is to prevent unnecessary radiation for the patient in case of a malfunction of the installation or a mistake when handling the X-ray equipment.

**AEC fault exposure detection = ON**

The factors determining whether the 4% dose value at 10% of the APR backup time are checked are

- the 10% backup time value > 10ms
- the expected 4% density voltage value > 20mV

In case of APR100 the check could be performed because the density voltage values are high enough.

The density voltage at 10% of the backup time would be too small to be measured for APR800, therefore the exposure continues up to the 9.5 x APR mAs value. The exposure finally terminates at 570mAs if the APR mAs value is ≥ 60mAs.

With APR100* the exposure terminates at 10% of the max backup time, which is 4000ms for all AEC exposures after overriding of any APR parameters. (The 600mAs limit does not switch OFF the exposure, 1500mA emission current is not available).

With APR800* the exposure terminates either at 600mAs or 4000ms, depending on which of the limits is reached first.

**AEC fault exposure detection = OFF**

APR100 and APR800 exposures have the same termination point at 9.5 x APR mAs. The exposure finally terminates at 570mAs, if the APR mAs value is ≥ 60mAs.

APR100* and APR800* exposures terminate either at 600mAs or at 4000ms, depending on which of the limits is reached first.

For explanations see figure and list of terms on following 2 pages.



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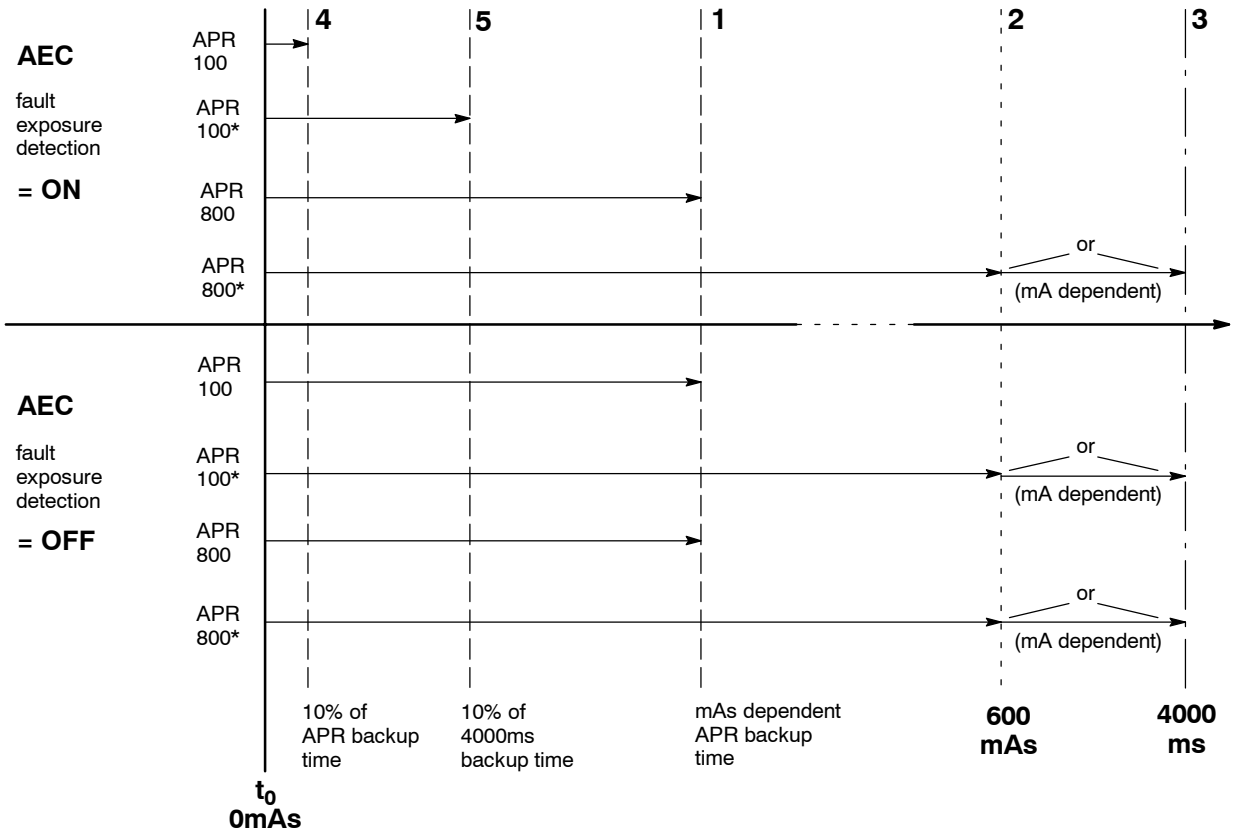


**AEC fault exposure detection strategy**

413H01


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**List of terms**

AEC = Automatic Exposure Control

APR100 = APR program with a less sensible film/screen combination of 100 speed, original parameters as programmed.

APR100* = as same as APR100, but parameter(s) modified on the control desk (overriding).

APR800 = APR program with a very sensible film/screen combination of 800 speed, original parameters as programmed.

APR800* = as same as APR800, but parameter(s) modified on the control desk (overriding).

600mAs = programmed mAs limit for AEC exposures (can be changed, must comply with the local regulations).

4000ms = max time limit of AEC exposures (cannot be changed).

1 = point of the mAs dependent APR backup time, which is calculated from the 9.5 x (typical) organ mAs value of the APR
2 = max mAs limit for AEC exposures (can be changed)
3 = max exposure time limit of 4000ms (cannot be changed)
4 = 10% (of the APR backup) time point
5 = 10% backup time point of the max exposure time limit (4000ms) = always 400ms

To explain the difference in switching the fault exposure detection **ON** or **OFF**, a very sensible (800 speed system) and a less sensible (100 speed system) film/screen combination have been chosen.



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# 15. Explanations on programming the generator

- Select menu:
  OPTIMUS\ PROGRAM\ DOSE RATE CONTROL\ **CONT ...**

**scantime_TV [ms]:** [20.000] = default 20ms
20ms must be programmed for all TV chains with a scantime ≤ 20ms.

- In case a TV chain has a longer scantime program the actual scantime value:

scantime_TV [ms] = [20.000] for scantime of TV chain ≤ 20ms
or
scantime_TV [ms] = [ xx.xxx] for scantime of TV chain = xx.xxx ms > 20ms

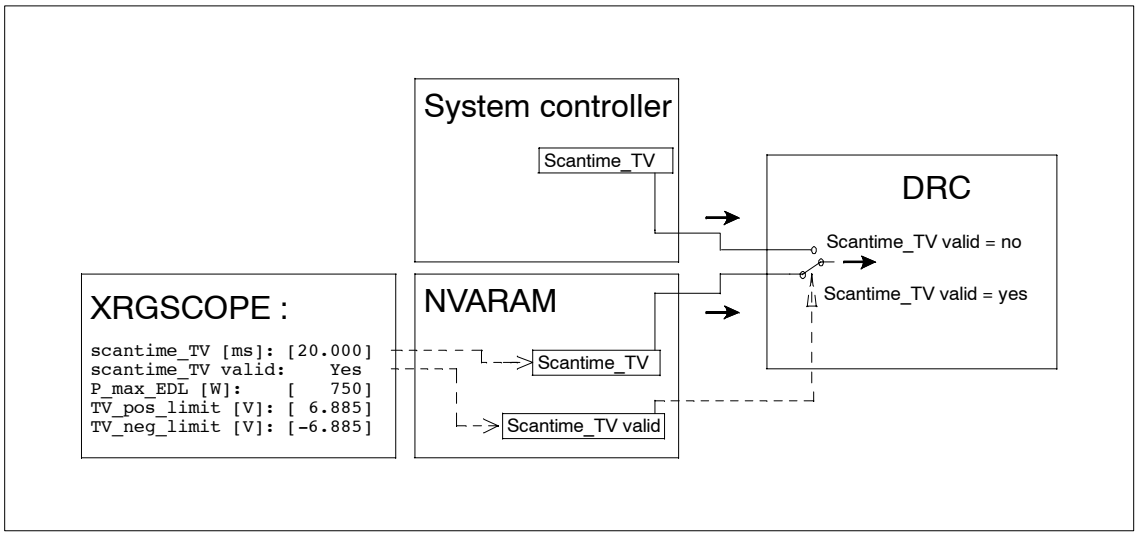
**scantime_TV valid:** YES (default)

With **YES**, the programmed variable scantime_TV [ms] is used for the control in FU Dose Rate Control (DRC).

At the moment only this value is possible.

With **NO**, the programmed variable scantime_TV [ms] is **not** used for the control in FU Dose Rate Control (DRC).
The variable is delivered by the system controller.
This version is a future option. At the moment it is not applicable.

See figure explaining the program settings below:





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# 16. Printed-circuit boards

**Low-voltage power supply: EZ102**

Also see Z1–2.3 ”Low-voltage power supply”.

LEDs H2 to H5 indicate whether the supply voltages are present.

The low-voltage power supplies of PCB EZ102 are short circuit proof. Therefore it is most likely that in case one of the LEDs grows dark one of the external consumers and not the PCB itself is the cause of the error.

It is recommended that one after the other all consumers be disconnected from the respective power supply until the LED is illuminated again.

The last consumer that was removed has probably caused the short-circuit.



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* EZ130 dependent on SW Rel.-level

Central rack,
service aid

A2/A4 01-10-24 Schr.


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# REPLACEMENT

## TEXT


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# 1. Traceable items

Trace items are:

1. Generator cabinet
2. H.V. tank

They are labelled as follows:

- type number
- serial number (s/n)
- manufacturer
- HHS certification
- code number

} combined label

With new traceable items for replacement a separate label is delivered.
This must be affixed to the label bracket on the top left corner of the generator cabinet.
See drawing 2Z–10 “Labelling”.

The new type number, code number and serial number must be entered on the master card for the generator.

Please, send a copy of the corrected master card as FAX to:

Philips Medical Systems
DMC Hamburg, Germany
Department: GEN–OPERATION
FAX No.: +49 40 5078 1247

## 1.1. Generator cabinet

The generator cabinet as a traceable item is labelled by a 6–digit serial number:

Example:

s/n **02 1234**

Meaning:

| | | |
|---|---|---|
| 02 | = | year of manufacture, e.g. 20**02** |
| 1234 | = | consecutive number |


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## 1.2. H.V. tank

H.V. tanks have a 7-digit serial number which has the following meaning:

Example:

s/n **02 01 123**

Meaning:

| | | |
|---|---|---|
| 02 | = | year of manufacture, e.g. 20**02** |
| 01 | = | power class, e.g. 50kW, 1 tube |
| 123 | = | consecutive number |

Power classes:

| | | |
|---|---|---|
| 01 | = | 50kW, 1 tube |
| 03 | = | 65/80kW, 1 tube |

**Caution!**
**An exchange of a H.V. tank requires a new alignment of "Function Unit kV".**
**For alignment work refer to chapter 4 in this section.**


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## 2. Printed-circuit boards

| PCB | HW programming | SW programming via XRGSCOPE | Tube adaptation | Remarks |
|---|---|---|---|---|
| EZ backpanel | • see Z2–5.1/.2/.3 | | | To attend to:<br>X4 emergency OFF<br>X10 EN_X/<br>X42 system CAN termination<br>X44 function programming plug<br>X45 generator CAN termination<br>X52 shall not be present |
| EZ102 low voltage supply | | | | |
| EZ119 mA control | • exchange PROM or insert new PROM<br>• set battery jumper to ON<br>• see 5Z–1 | • load tube data set(s) | all tubes | Bucky TH, Digital Diagnost, Thoravision systems:<br>• Set RGDV according to adaptation. See section 2, chapter 8.3.2. |
| EZ130 kV control | • exchange PROM or insert new PROM<br>• see 5Z–1 | | | • Carry out alignment of ”Function Unit kV”. |
| EZ139 CU | • exchange BOOT PROM or insert new PROM<br>• see 5Z–1 | • set date and time<br>• restore CU complete or start programming from beginning | | • Carry out alignment of ”Function Unit kV” if no CU complete files are present. |
| EZ150 basic interface | • see 5Z–1 | • check AMPLIMAT sensitivity according to jumper W4 | | • Set jumpers W2 + W3 according to required chamber supply.<br>• Set jumper W4 according to programmed AMPLIMAT sensitivity. |


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| PCB | HW programming | SW programming via XRGSCOPE | Tube adaptation | Remarks |
|---|---|---|---|---|
| EN100 power ON circuit | | | | |
| EG100 measuring circuit | | | | Exchange is not allowed.<br>Requires alignment which is not possible in the field.<br>• Exchange the whole tank. |
| EY100 rotor control high speed | • swap PROM or insert new PROM<br>• see 5Z-2 | | | |


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# 3. Exchange of firmware or update to Rel. 1.2

**NC: 9890 000 0259x Firmware OPTIMUS C Rel. 1.2**
**4512 114 2691x Central Unit**

It must be loaded from the PC into the respective flash PROMs.

For loading firmware release 1.2 the following firmware levels must be present in the generator:

| | | | |
|---|---|---|---|
| - CU-Boot | : | ≥ 4512 113 2700x | |
| - FU-kV | : | ≥ 4512 113 2621x | OPTIMUS R/F + C |
| - FU-mA | : | ≥ 4512 113 2021x | |
| - FU-CIE | : | ≥ 4512 113 2031x | |
| - FU-RoCo | : | ≥ 4512 113 2232x | units 4512 104 7142x |
| | | ≥ 4512 113 2231x | units 4512 104 7140x |

**Caution!**
**Before changing the release, save all configuration data of the generator!**
**Refer to chapter 3.2.1 “Backup of all configuration data”.**

## 3.1. Preparation of the service PC to guarantee a safe loading process

Start XRGSCOPE always from DOS if possible.

In case of any WINDOWS version:

- Switch OFF all screensavers.
- Do not run other programs.
- Do not insert any CD in the drive.

Any kind of power management of the PC hardware (BIOS) as well as the windows power management should be switched OFF.
If the PC is connected to mains power some of these might be automatically OFF.


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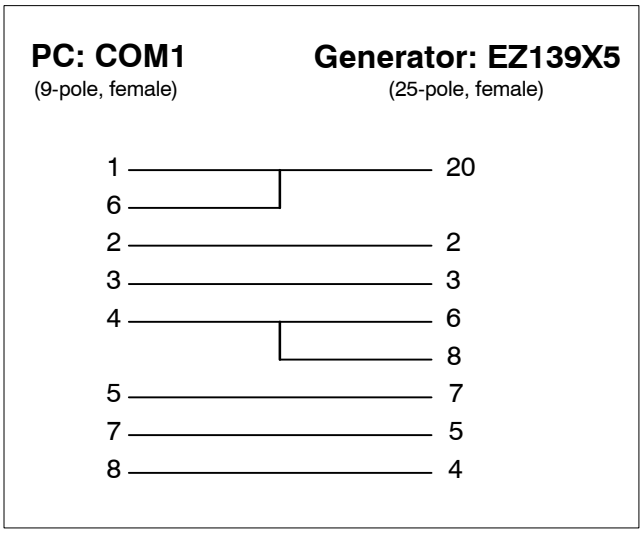
## 3.2. Backup / Installation procedure

- Provide the service PC with the hardware key and switch it ON.
  The hardware key provides access to special program settings and to menu ***"Faultfind".***
  Standard programming is possible without a hardware key.
- Connect the PC to X5 on EZ139 CENTRAL UNIT CU via a serial data cable:
  (A 5m long data cable can be ordered via 12NC: 4512 130 56931)




- Insert the floppy disk containing the self-unpacking exe-files of the firmware in the disk drive of the PC:
  - OMC : 4512 116 024xx
  For unpacking on the harddisk of the PC about 5MB are needed.
- Generate a directory e.g. [C:\OPT_C] on the PC by typing **<md C:\OPT_C>** or use WIN commands.
- Copy the firmware from floppy disk to the PC into the same directory [C:\OPT_C] by typing **<copy A:*.* C:\OPT_C>** or use WIN commands.
- Start unpacking the programs by typing **<OMCxxxxx.exe>** or doubleclick on **<*.exe>** -file.
  The program unpack all files needed for the update of the firmware and the newest service tools.
- After unpacking [OMCxxxxx.exe] can be deleted on the harddisk by typing **<del OMCxxxxx.exe>**.
- For the current contents of [OMCxxxxx.exe] read [OMCxxxxx.txt] on the floppy disk.
- For further installation of the firmware in the generator read [README.txt].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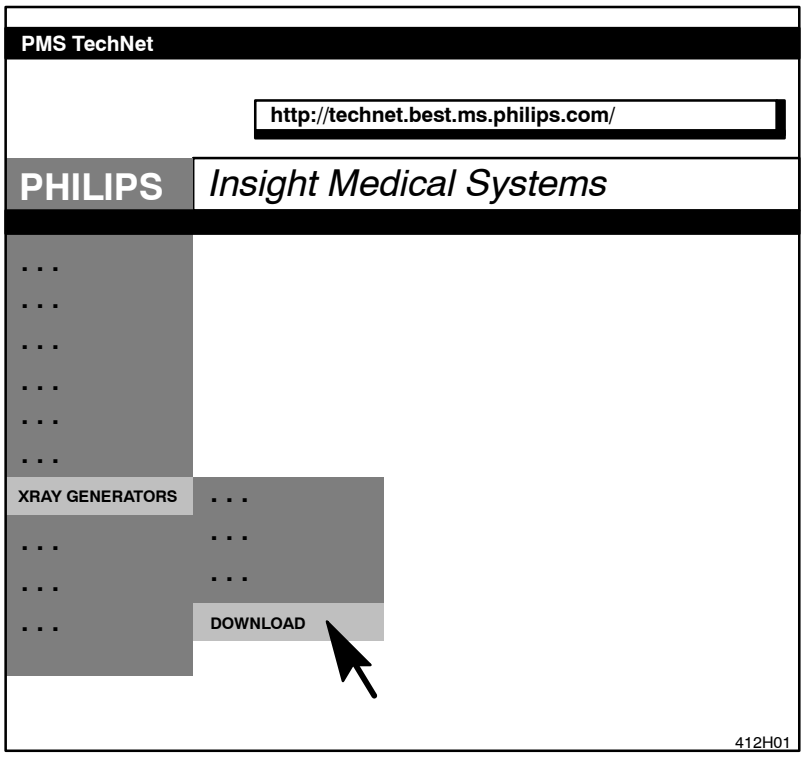
General information:

- Button **<F1>** **<help>** Call help / cancel help.
- Button **<F2>** **<transmit>** Store screen contents / data set in the generator ==> transmit to generator.
- Button **<F3>** **<save>** Store data screen on disk.
  For an open data screen the path desired can be selected.
- Button **<F4>** **<load>** Load data set from disk. The desired path can be selected.
- Button **<ESC>** Commands one step back. Can be used repeatedly.
- Fields with ↓ Select the possible range of values by pushing **<RETURN>**.
  The data are specified by the generator as fixed values.
- Fields with **[...]** Input of data via the keyboard.

Error numbers which appear at the beginning of the programming procedure must be erased from the screen by pushing the **<RETURN>** key.

Current data files, for instance, for online help, tube types, APR programming are available in the PHILIPS-Intranet. Use path ***http://technet.best.ms.philips.com/*** and pull down menu as shown below.




If you call the installation program with **<xrgscope ?>** the possible starting parameters for the service program are listed.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### 3.2.1. Backup of all configuration data

- Switch ON the generator.

To save the configuration data use the CONFIGURATION BACKUP disk supplied.

- Save the complete SW programming of the generator on the floppy disk by using the menu:
  ACCEPT/ BACKUP/ **CU complete**

  A disk space of 700kByte is required.
  It takes about 8min to save the data to the disk.

  The default backup name:
  Backup File Name: **CUBACKUP.TDL**
  The name can be changed into any other filename.
  The path (harddisk) is automatically taken into account.
  It is also possible to type:
  **A:\"filename"** <RETURN>
  to load the backup files directly to the floppy disk.

### 3.2.2. Loading the new firmware into the generator

- Switch OFF the generator.
- When installing the firmware

  from COM 1 enter FLASH1.BAT
  from COM 2 enter FLASH2.BAT

  "Attempting link" appears on the screen.
- Switch ON the generator.

  Depending on the type of PC data transmission takes 15 ... 30min.
  During this process all red LEDs of the function unit are blinking.

  **Caution!**
  **When the data transmission to the generator is completed, the scope program is still active. This is unfortunately not displayed on the screen. For several minutes, while the screen is blank, the flash PROMs are loaded into the generator. This process must under no circumstances be disturbed! At the end of this sensible procedure "Flash loaded o.k." appears on the screen. Only now the scope program can be terminated.**

- Reset the generator.


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# 4. Replacement of parts of ”Function Unit kV”

In case one of the following assemblies:

- PCB kV-control 3 / 4 (EZ130)
- Converter (EQ)
- H.V. tank (EG)
- PCB Central unit (EZ139)

of ”Function Unit kV” has been exchanged, the alignment of the ”Function Unit kV” must be repeated.

## 4.1. General information

The actual value of the set kV must be attained at least after 2ms. At kV rise phase there must be neither kV break-in nor a kV overshoot.

The Factor Duty Cycle is based on an adapted tube and determines at local mains voltage and mains resistance conditions:

- the kV rise phase
- the kV behavior during the exposure in falling load technique

The Factor Duty Cycle is stored in the memory of PCB CU EZ139. If the CU has to be replaced the CU complete backup can be reloaded (with the actual factor) to the NVRAM memory or the Factor Duty Cycle must be re-aligned. Refer to figure 1:

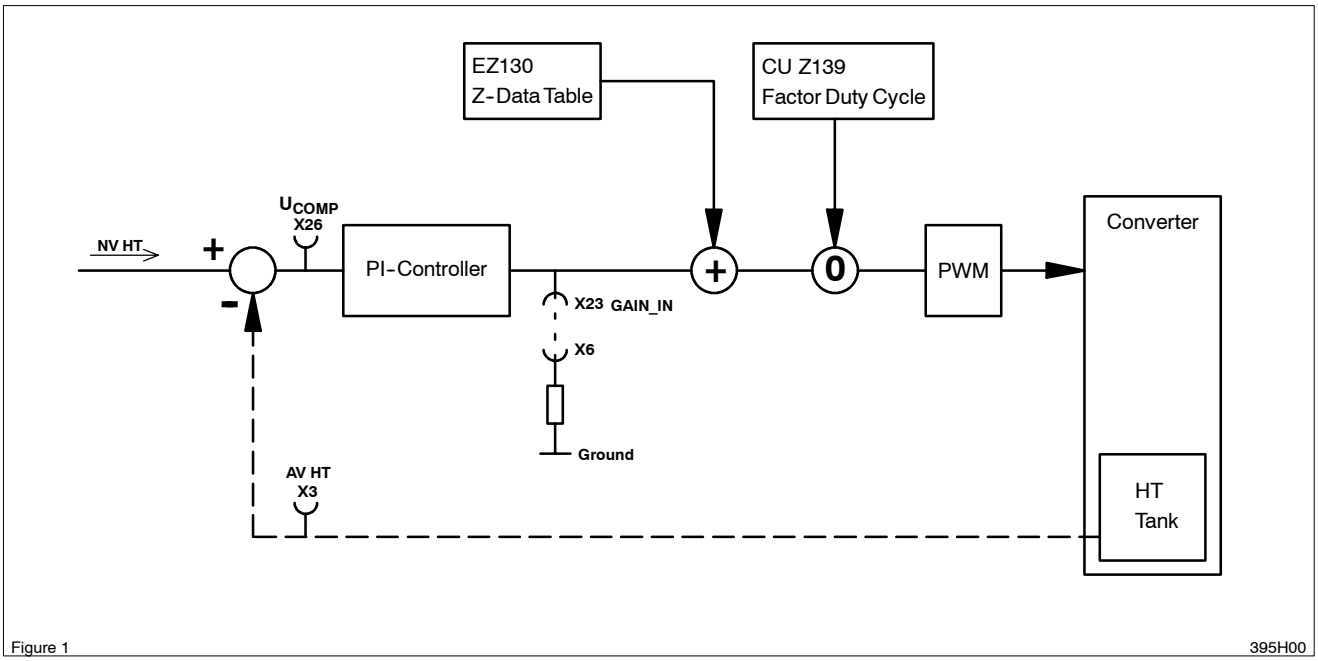


Figure 1 395H00

During alignment this Factor Duty Cycle must be entered via XRGSCOPE. The influence of this factor as a correction value for the Z-Data Table is monitored as the $U_{COMP}$ signal, since the PI-Controller is deactivated by the grounded *GAIN_IN* signal.


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## 4.2. Connecting and setting the scope

For connections see figure 2:

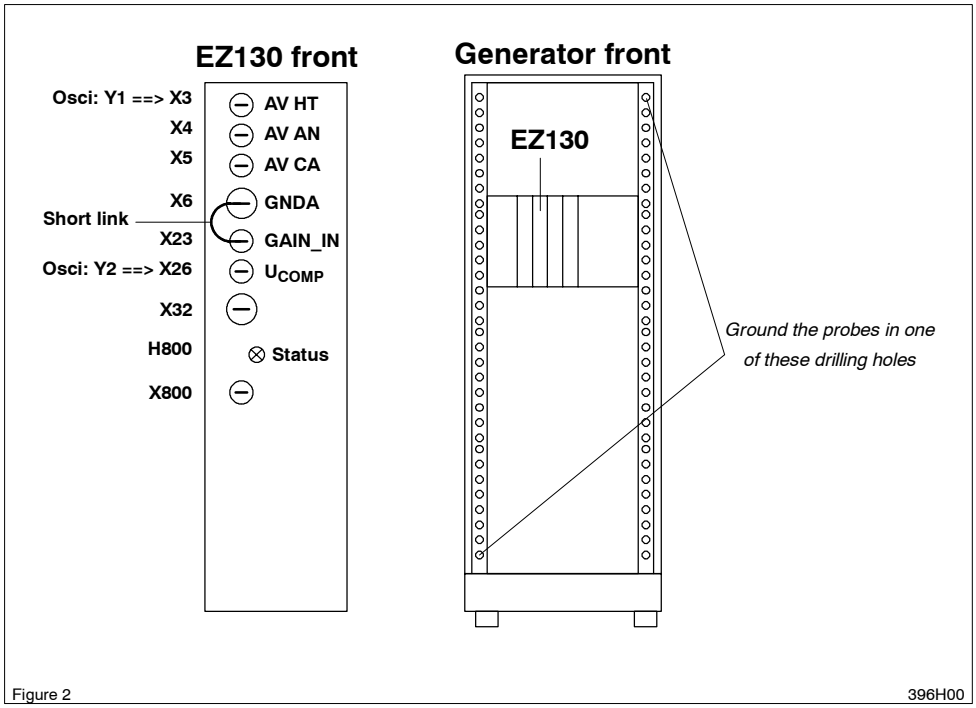


Figure 2 396H00

Channel 1 = EZ130 X3 ---> *AV HT* ---> 20kV/V ---> 1V/div --> Zero-line at bottom of screen
Probe GND = one of the drilling holes at the front cabinet chassis

Channel 2 = EZ130 X26 ---> $U_{COMP}$ ---> 1V/div ---> Zero-line 2 div from bottom of screen
Probe GND = one of the drilling holes at the front cabinet chassis

Trigger = external (preferred) ---> *CTRL_X_C/* ---> backpanel EZX74 / negative slope
or = internal channel 1 ---> *AV HT* ---> EZ130 X3 / positive slope at +3V
Probe GND = one of the drilling holes at the front cabinet chassis

Time base = 5 or 10ms/div ---> trigger delay -1div

**Note**
*A digital scope should not have any other ground connection than the ground of the 3 probes at the drilling holes at the front generator chassis.*
*A mains-driven scope must be isolated from earth potential, otherwise it might display artefacts.*


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## 4.3. Deactivating the kV controller

- Connect EZ130 X23 *GAIN_IN* and X6 *GNDA* with a short link (use a short wire).

### Caution!

**This alignment requires exposures with high kV.**
**Be sure the tube has been warmed up before.**

## 4.4. Setting of exposure data

**a) Set 141kV in case of**

- 65/80kW
- the tube limit (of at least one tube) is 150kV perform this adjustment at the tube which has the highest kV limit programmed.

**b) Set 125kV in case of**

- 50kW
  and
- 65/80kW if the programmed application limit of the tube limit is 125kV.

**Note**
*Any tube arcing during this adjustment requires the execution of the tube conditioning next as described in section 2 "INSTALLATION".*
*Disconnect the short link between X23 and X6.*
*Start over this adjustment from chapter 2.3 onwards if the tube conditioning was successful.*

- Set kV and mA values according to the programmed tube limits:

| | | | | |
|---|---|---|---|---|
| **a) 141kV:** | 200mA | at | kV_4 | (65/80kW) |
| **b) 125kV:** | 100mA | at | kV_3 | (50kW) |
| | 200mA | at | kV_4 | (65/80kW) |

- Set exposure time: 40ms


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## 4.5. Adjustment of the ”factor for duty cycle”

- Adjust the Factor Duty Cycle via service software XRGSCOPE by measuring $U_{COMP}$ with the scope.
- Connect the service PC and start XRGSCOPE:
  XRGSCOPE
  SELECT UNIT ---> FU-kV ---> ADJUST ---> IGBT Pulse Width Correction ---> Factor Duty Cycle
- Set the starting value Factor Duty Cycle to **1.00**:

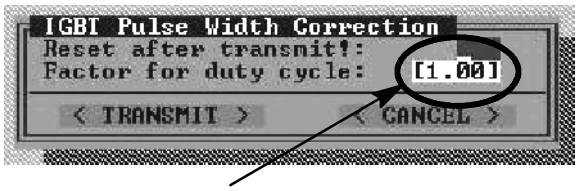
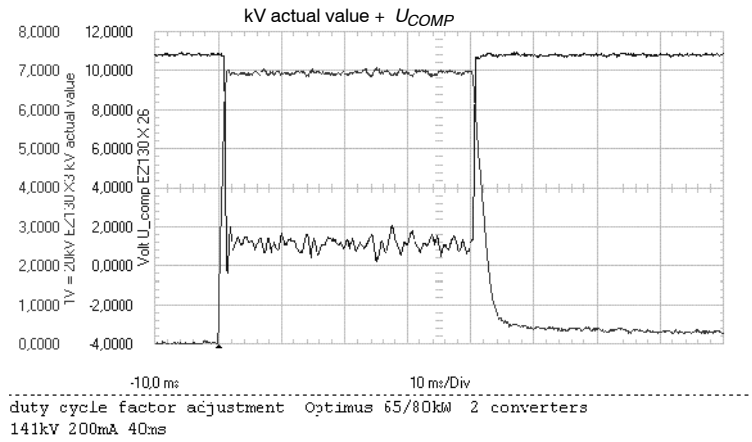


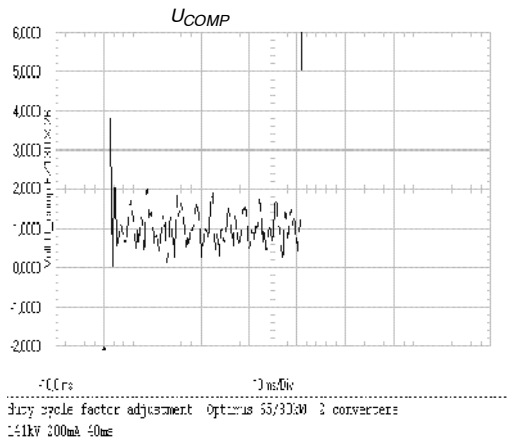

Figure 3 397H00

- If the $U_{COMP}$ value does not match the requirements type in another Factor Duty Cycle value, <TRANSMIT> the screen and push the active RGDV button to get the new value validated.
- Switch an exposure.
  The values are measured in the stationary condition. The transient behavior at the beginning of the exposure is not taken into account.

**Result**: In standby the $U_{COMP}$ value is at about +11V, during exposure the mean value $U_{COMP}$ must be as given in table 1 or 2, refer to figure 4:




Oscillogram of a perfect alignment for 141kV




$U_{COMP}$ for 141kV

Figure 4 401H00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**a) 141kV setting (65/80kW only)**

- Read the mean value of $U_{COMP}$ for 141kV (see scope figure 4 or 5), correct the Factor Duty Cycle till $U_{COMP}$ meets the required reference of +1V.

| kV setpoint | mA setpoint | PCB type | $U_{COMP}$ | Tolerance | kV peak of *AV HT* | Factor Duty Cycle: | Date: |
|---|---|---|---|---|---|---|---|
| 141kV | 200mA | PCB kV_control 4: | +1V | ±0.5V | 138kV | | |

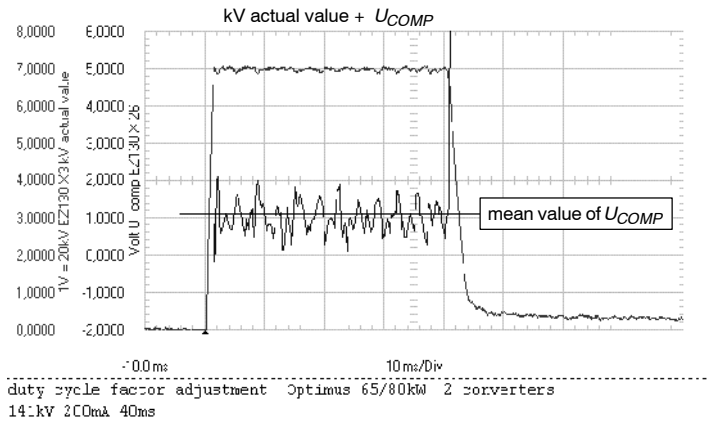
Table 1: Factor Duty Cycle, settings 141kV (150kV limit)

Example how to correct the Factor Duty Cycle:

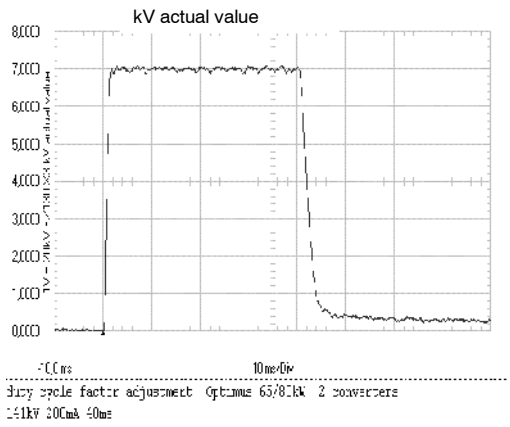
**PCB kV_control 4:**

- If the mean value of $U_{COMP}$ is: > +1.5V **increase** the Factor Duty Cycle in steps of 0.01
  < +0.5V **decrease** the Factor Duty Cycle in steps of 0.01

- Check also the kV peak value *AV HT* (not the overshoot), it must be **138kV** for **141kV** setpoint. (see scope figure 5)
- Remove short link EZ130 X23 *GAIN_IN*.
- Record the findings in table1.




Optimus 80kW with 141kV, $U_{COMP}$ = +1V




*AV HT* with overshoot

Figure 5 402H00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**b) 125kV setting (50/65/80kW)**

- Read the mean value of $U_{COMP}$ for 125kV (in principle figure 4 or 5).
- Correct the Factor Duty Cycle till $U_{COMP}$ meets the required reference of 0V.

| kV setpoint | mA setpoint | PCB type | $U_{COMP}$ | Tolerance | kV peak of *AV HT* | Factor Duty Cycle: | Date: |
|---|---|---|---|---|---|---|---|
| 125kV | 100mA | PCB kV_control 3: | +0V | +1V / -0,5V | 125kV | | |
| 125kV | 200mA | PCB kV_control 4: | +0V | ±0.5V | 125kV | | |

Table 2: Factor Duty Cycle, 125kV limit

Example how to correct the Factor Duty Cycle:

**PCB kV_control 3:**

- If the mean value of $U_{COMP}$ is: > +1V **increase** the Factor Duty Cycle in steps of 0.01
  < -0.5V **decrease** the Factor Duty Cycle in steps of 0.01

**PCB kV_control 4:**

- If the mean value of $U_{COMP}$ is: > +0.5V **increase** the Factor Duty Cycle in steps of 0.01
  < -0.5V **decrease** the Factor Duty Cycle in steps of 0.01

- Check also the kV peak value *AV HT* (not the overshoot), it must be **125kV** for **125kV** setpoint.
- Remove short link EZ130 X23 *GAIN_IN*.
- Record the findings in table 2.


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# 5. Tube replacement

Any new tube require a new adjustment procedure consisting of:

1. Tube conditioning
2. Tube adaptation

**Warning!**
**Radiation is released during the adjustment procedure!**

**The generator must be in the READY state, i.e. the green ring at the desk must be illuminated!**

## 5.1. Tube conditioning

- Select free cassette auxiliary.
- Select **large** focus only.

**Note**
*The generator must be in the* READY *state.*

- Run conditioning procedure for a new or non-adapted tube, refer to following table “Exposure parameters for conditioning“.
- It is recommended that the high tension be monitored during conditioning.
  Connect the scope:
  Channel1: kV AV HT at EZ130 X3 (1V/div), scale: 20kV/V
  Trigger external: CTRL_X_C/ at backpanel EZ X74, negative slope
  Time base: 2ms/div
- In case of problems like tube arcing see the following flowchart EXPOSURE SEQUENCE as an example.
  The flowchart applies for applicable kV range only, e. g.:
  109kV is the max. kV value for normal application, perform just up to next higher kV step = 117kV.

**Note**
*Refer to* flowchart EXPOSURE SEQUENCE.
*If the tube arcs at a certain kV value, switch another 3 exposures with same parameters and 10s pause between subsequent exposures. In case of success (no arcing anymore) continue with next kV step of the following table.*
*If the last exposure still arcs go one kV step back and follow normal procedure. If this routine has been performed three times without improvement:* ==> **Replace the tube!**


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| Exposure parameters for conditioning | | |
|---|---|---|
| **kV** | **mAs** | **# exposures** |
| 80 | 0.5 | < 1 > |
| 80 | 5 | < 1 > |
| 80 | 50 | < 1 > |
| 10 seconds pause | | |
| 80 | 100 | < 1 > |
| 1 minute pause | | |
| 90 | 0.5 | < 1 > |
| 90 | 5 | < 1 > |
| 90 | 50 | < 1 > |
| 10 seconds pause | | |
| 90 | 100 | < 1 > |
| 1 minute pause | | |
| 100 | 0.5 | < 1 > |
| 100 | 5 | < 1 > |
| 100 | 50 | < 1 > |
| 10 seconds pause | | |
| 100 | 100 | < 1 > |
| 1 minute pause | | |
| 110 | 0.5 | < 1 > |
| 110 | 5 | < 1 > |
| 110 | 50 | < 1 > |
| 10 seconds pause | | |
| 110 | 100 | < 1 > |
| 1 minute pause | | |
| 120 | 0.5 | < 1 > |
| 120 | 5 | < 1 > |
| 120 | 50 | < 1 > |
| 10 seconds pause | | |
| 120 | 100 | < 1 > |
| 1 minute pause | | |
| 130 | 0.5 | < 1 > |
| 130 | 5 | < 1 > |
| 130 | 50 | < 1 > |
| 10 seconds pause | | |
| 130 | 100 | < 1 > |
| 1 minute pause | | |


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| Exposure parameters for conditioning | | |
|---|---|---|
| **kV** | **mAs** | **# exposures** |
| 140 | 0.5 | < 1 > |
| 140 | 5 | < 1 > |
| 140 | 50 | < 1 > |
| 10 seconds pause | | |
| 140* | 100 | < 1 > |
| 1 minute pause | | |
| 145 | 0.5 | < 1 > |
| 145 | 5 | < 1 > |
| 145 | 50 | < 1 > |
| 10 seconds pause | | |
| 145 | 100 | < 1 > |
| 1 minute pause | | |
| 148 | 0.5 | < 1 > |
| 148 | 5 | < 1 > |
| 148 | 50 | < 1 > |
| 10 seconds pause | | |
| 148 | 100 | < 1 > |
| 1 minute pause | | |
| 150 | 0.5 | < 1 > |
| 150 | 5 | < 1 > |
| 150 | 50 | < 1 > |
| 10 seconds pause | | |
| 150 | 100 | < 1 > |
| 1 minute pause | | |


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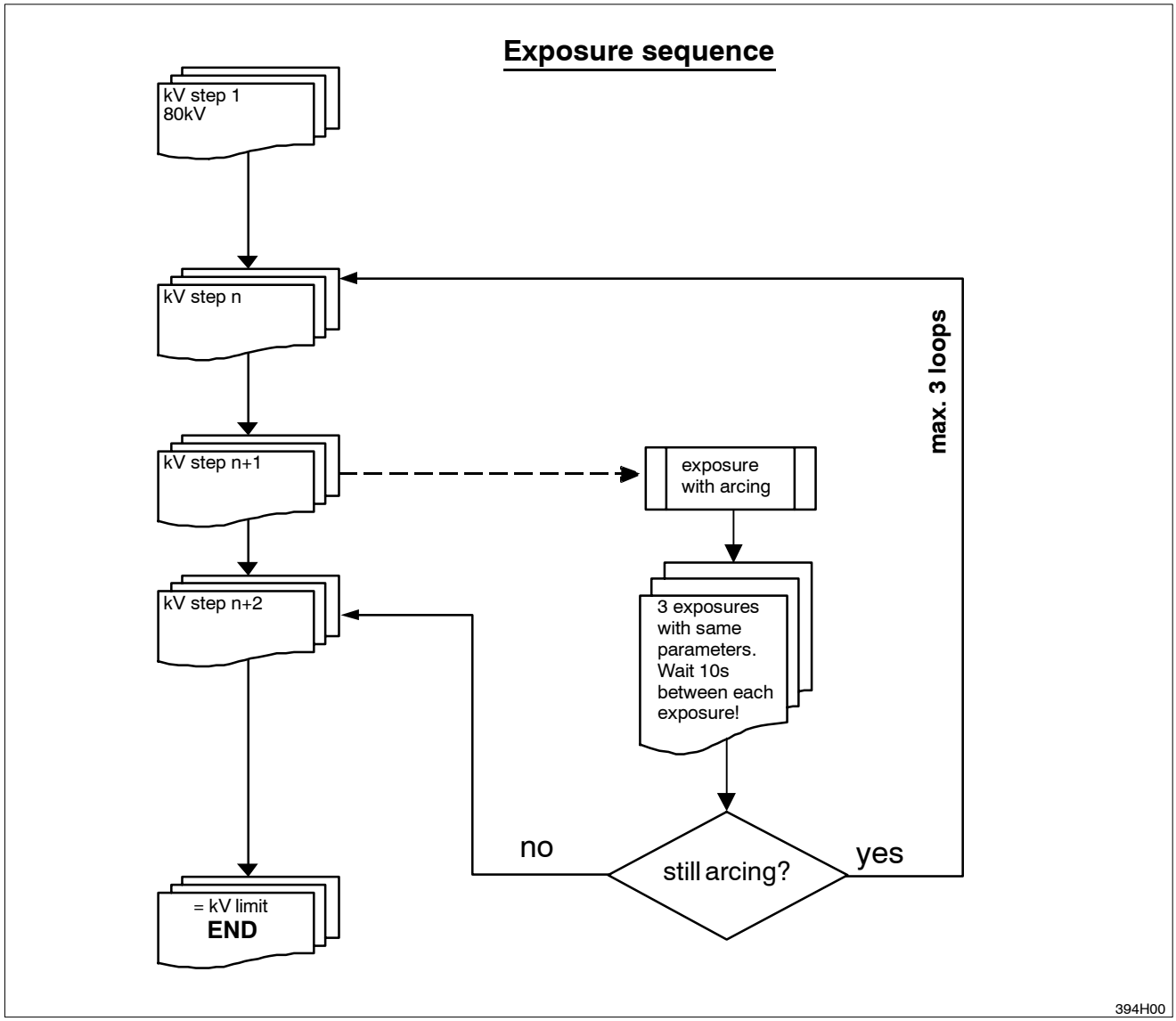


**Note**

*If a tube arcs at any kV value which is not required for application the max. kV (e.g.117kV) program this new limit value by* XRGSCOPE:
PROGRAM/ TUBES/ TUBE LIMITS/ MAX. TUBE VOLTAGE LIMIT [kV]/ **[117]**

As the limit value decreases for this reason, a following re-adaptation procedure sets the field ADAPTED TO [kV] to this value as well.

- Set RGDV programming to original status if no adaptation procedure has to be executed.
- RESET the generator.


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## 5.2. Tube adaptation

### 5.2.1. General information

Tube adaptation is an automatic process which includes:

1. The measurement of the mA offset value that is caused by:
   - the kV measuring circuit
   - the emission current feedback circuit (VCO)

2. The measurement of the individual standby filament current (based on 100μA).

3. The emission current characteristic as f (kV, filament current).

4. The dynamic behavior (positive and negative boost adaptation) where the inertia of the filament with respect to heating up and cooling down is registered.
   For more information refer to section 3: FAULT FINDING.

**Note**
*In case of problems check the symptom / solution list at the end of this adjustment chapter. Repeat the adaptation for this particular focus.*


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### 5.2.2. Procedure

**Note**
*The tube must be properly conditioned before starting the adaptation procedure.*
*For break-in procedure see previous chapter 8.2.1. "Tube conditioning".*

Tube adaptation is an automatic process which includes:

1. The measurement of the mA offset of
   - the kV measuring circuit.
   - the emission current voltage / frequency converter.

2. The measurement of the individual standby filament current.

3. The kV dependent filament / emission current behavior.

4. The boost adaptation to calculate the positive and negative boost in one procedure.
   For more information refer to section 3: FAULT FINDING.

**Note**
*In case of problems check the symptom / solution list at the end of this chapter.*
*Repeat the adaptation for this particular focus.*

- Press **<RETURN>**.
  An opening screen asks to wait 20 seconds after the screen comes up.
- Thereafter the data has been transmitted by pressing **<F2>**.

**Tube:** **1st Tube**
**2nd Tube** not applicable
**3rd Tube** not applicable

**Focus:** **small**
**medium** a tube with a (third) medium filament does not exist yet, it is **not** VARIOFOCUS
**large**


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After data transmission COCKPIT displays **[Adaptation X-Ray tube]** (locally programmed language).
READY returns (waiting time is in the order of 15 seconds).

- Push **<PREP>** and **<EXP>** button at the control desk or use footswitch.

The generator switches about 125 exposures for each focus.
The radiation sign at the desk indicates exposures and a beep is audible at the end of every exposure.
There is no display of the actual kV parameters during adaptation.

The termination of the adaptation procedure will be indicated at the PC screen and a beep from the PC is audible.

- RESET the generator.

- Adapt **both** small and large focus to use VARIOFOCUS.
  APRs using VARIOFOCUS cannot be selected as long as **both**, small and large are not adapted.
  The COCKPIT screen indicates a non-adapted focus.


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## 5.3. Symptoms and solutions if problems occur during tube adjustment

1. A warning can not be displayed on the control desk, the WAITING screen on the PC is flickering instead during this event and logged in the error log index.

2. If the tube has already been in a high temperature level (but the traffic light still indicates green or green-yellow for 100% power) it might happen that the traffic light changes straight to red and the adaptation is on hold**.** WAITING is flickering on the PC.
   Solution: Keep the handswitch pushed, once the temperature is down adaptation continues automatically.

   **Note**
   *An increment of one of the temperature levels inhibits the 100% power condition. This event is always logged as warning 00BV in the error log index.*

3. An error message just flashes for a very short moment and instantly covered by ADAP on the desk afterwards. WAITING is flickering on the PC.

4. All buttons at the control desk including the RESET button are inactive during adaptation.
   The only way to RESET an error is to release the PREP switch which causes an interrupt similar to the RESET command.

5. After let go of the PREP switch wait until the desk indicates READY. If READY does not appear at least after 20 seconds run a warmstart of the generator by pushing the RESET button on CU EZ139.

6. If adaptation seems to do nothing for more than 30 seconds let go the PREP switch. Wait until the desk indicates READY. If READY does not appear at least after 20 seconds run a warmstart of the generator by pushing the RESET button on CU EZ139.

7. If a constant READY indication appears for more than 2 seconds while PREP and EXP is activated by the handswitch during adaptation let go the handswitch.
   Wait until the desk indicates READY. If READY does not appear at least after 20 seconds run a warmstart of the generator by pushing the RESET button on CU EZ139.

8. If adaptation does not carry on with or without READY indication check whether one of the function units indicates a FATAL error by turning on the red LED. Let go the handswitch and warmstart the generator by pushing the RESET button on CU EZ139.

9. If adaptation has been interrupted by a generator warmstart check the error log index before restarting adaptation:
   kV errors 02WG and/or 02WH indicate tube arcing. Run conditioning of the tube as described in section 2 “INSTALLATION” and/or reduce the max. kV value to the required application value.


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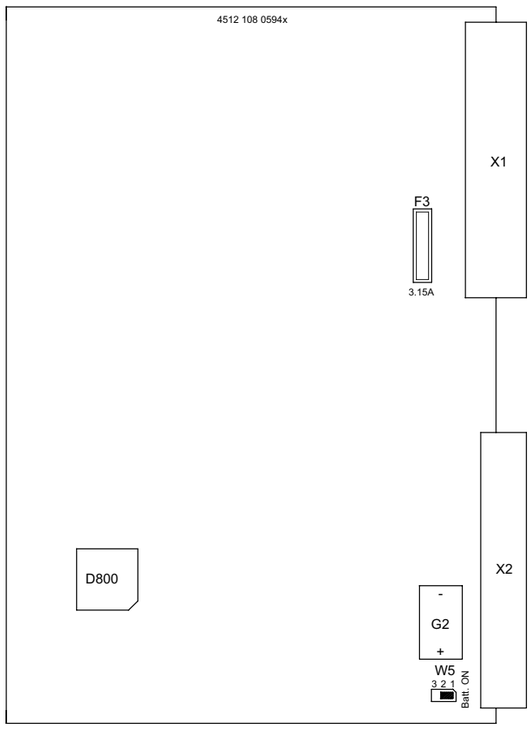
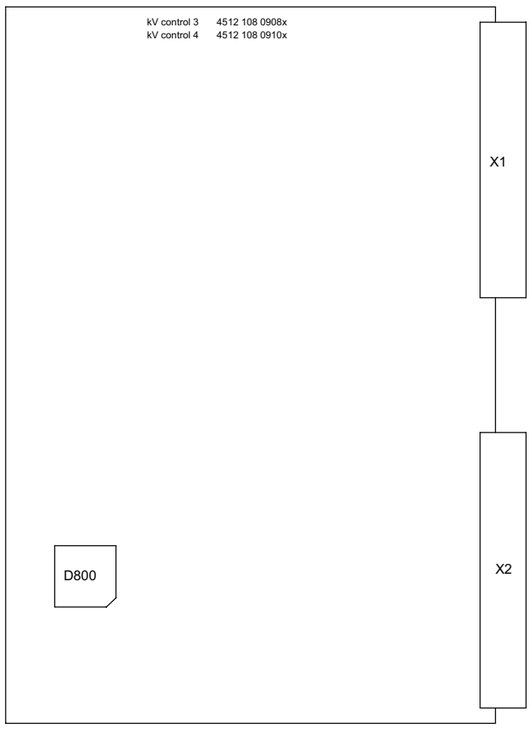
Attention: Do not forget to set the jumper of the battery in the position "Batt. ON":
EZ119: W5
EZ139: W1

## EZ 119 mA control



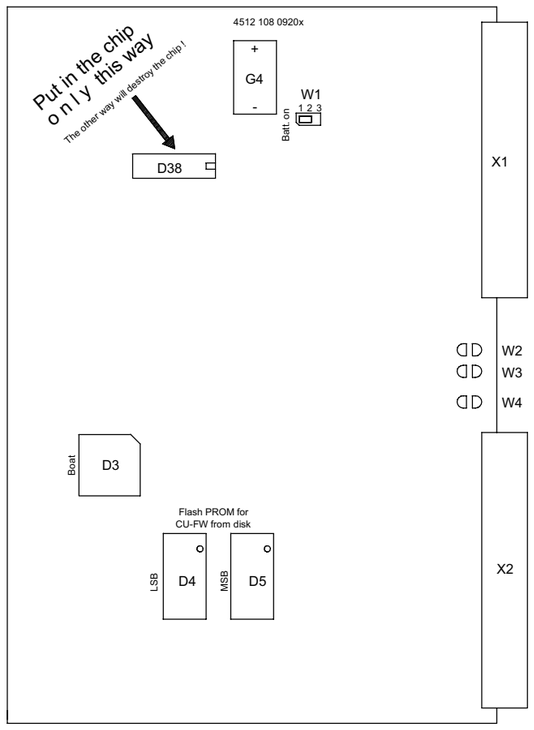

D800 = 4512 113 20211
= 4512 113 20212

## EZ 130 kV control 3/4




D800 = 4512 113 20132 RAD
D800 = 4512 113 26212 R/F

## EZ 139 Central unit

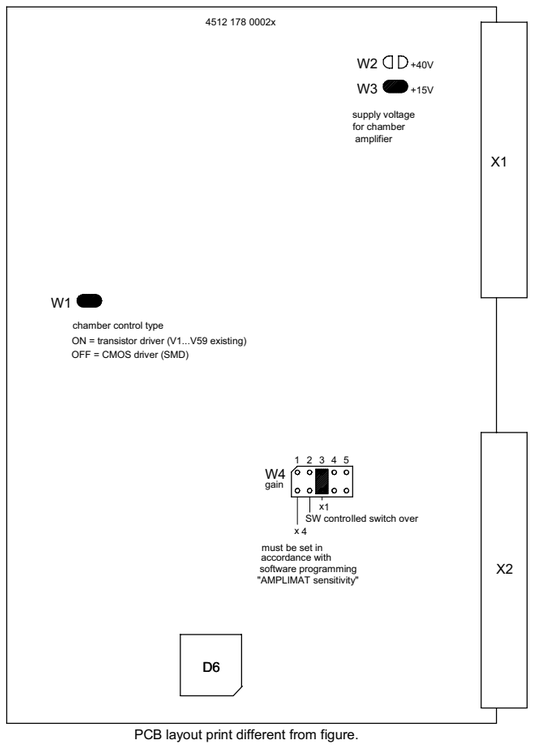



D38 = function key,
marked with s/n of the generator

OPTIMUS R/F :
OPTIMUS RAD :

Boot- FW D3 = 4512 113 20731
Cu - FW Rel 3.5 = 9890 000 02512 (4512 114 20835)
Cannot be ordered. Use OMA0220x. exe disk for flash PROM loading.

## EZ 150 Basic interface




PCB layout print different from figure.

D6 = 4512 113 20311

---

kV control 3 ≥ 4512 108 09081
kV control 4 ≥ 4512 108 09101

- OPTIMUS R/F
- OPTIMUS C
  D800 = 4512 113 26211
  = 4512 113 26212
- OPTIMUS RAD
  D800 = 4512 113 20131
  = 4512 113 20132

---

OPTIMUS C :

Boot- FW D3 = 4512 113 27001
Cu - FW Rel 1 = 9890 000 02541 (4512 114 26901)
Cannot be ordered. Use OMC0241x. exe disk for flash PROM loading.

A1/A3 01-11-12 Schr.

# PCB programming central rack EZ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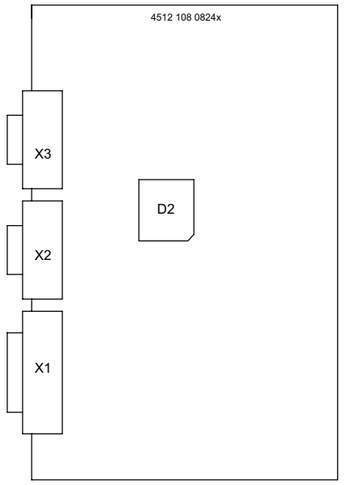
Operating desk C 1)

C 300 CPU

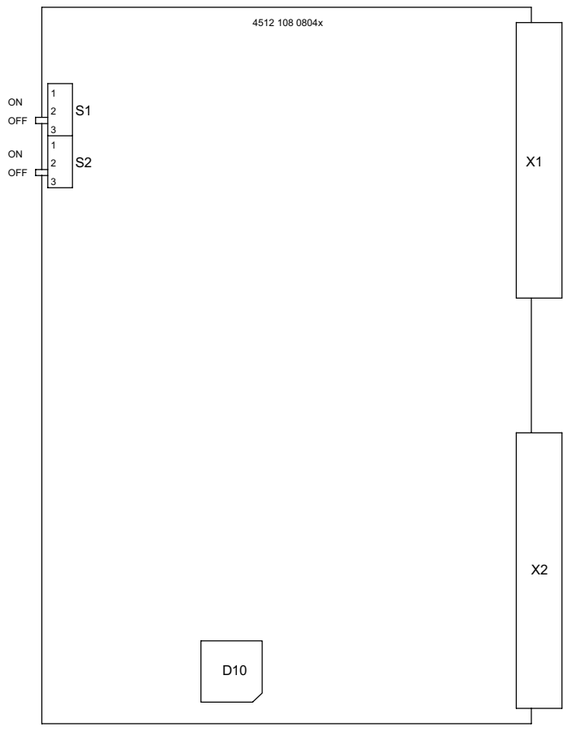



1) not for OPTIMUS C

D2 = 4512 113 20521
= 4512 113 20522
= 4512 113 20523
= 4512 113 20524
= 4512 113 20525

Adapter decade cable WA, 1WA, 2WA, 1WB 1)

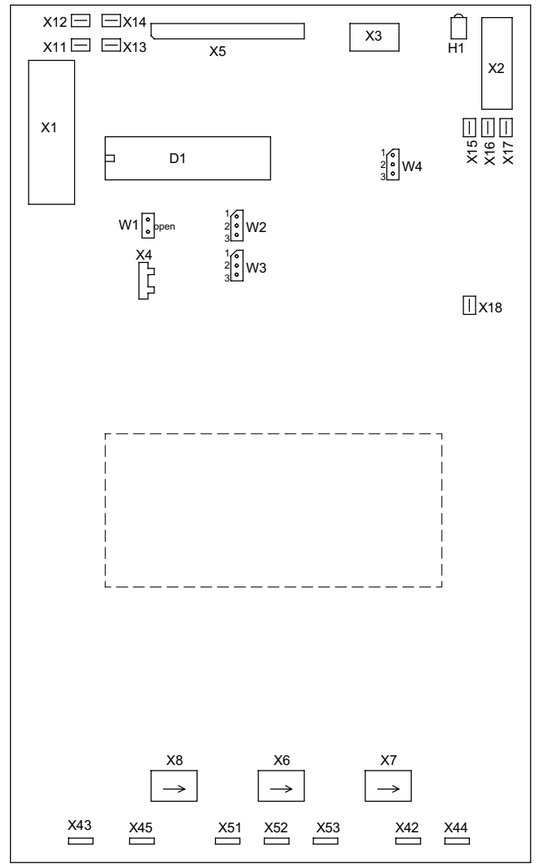
WB/WA 102 Universal I/O interface




D10 = 4512 113 20611

Ro Dual speed rotor control Y 9890 000 02662
Dual speed rotor control OPTIMUS Y 9890 000 0268x

Y 100 Roco HS 4512 108 0974x




| Coding | Rotor control 1st | Rotor control 2nd |
|---|---|---|
| W2 | 1 2 3 | 1 2 3 |
| W3 | 1 2 3 | 1 2 3 |

| W4 | Application of RoCo HS |
|---|---|
| 1 O<br>2 O open<br>3 O | normal |
| 1 O<br>2 O 2 - 3 closed<br>3 O | MRC solo |

D1 = 4512 113 22321
= 4512 113 22322
= 4512 113 22323

A1/A3 01-11-01 Schr.



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# ADJUSTMENTS

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# 1. Alignment of "Function Unit kV"

## 1.1. General information

The actual value of the set kV must be attained at least after 2ms. At kV rise phase there must be neither kV break-in nor a kV overshoot.

The Factor Duty Cycle is based on an adapted tube and determines at local mains voltage and mains resistance conditions:

- the kV rise phase

  and

- the kV behavior during the exposure in falling load technique

  as it takes into account the tolerances of the following FRUs (**F**ield **R**eplaceable **U**nits):

1. PCB EZ 130 **
   kV_control_3 = 50kW 1 converter 4512 108 0908x
   kV_control_4 = 65/80kW 2 converters 4512 108 0910x

2. A complete power converter unit Q **
   kV_power PCB(s) Q100 (part of the power converter unit)
   IGBT transistors (part of the power converter unit)

3. Resonance capacitors (part of the power converter unit) **

4. High tension transformer **

An exchange of one of the ** marked parts requires a realignment of the Factor Duty Cycle.

The Factor Duty Cycle is stored in the memory of PCB CU EZ139. If the CU has to be replaced the CU complete backup can be reloaded (with the actual factor) to the NVRAM memory or the Factor Duty Cycle must be re-aligned. Refer to figure 1:

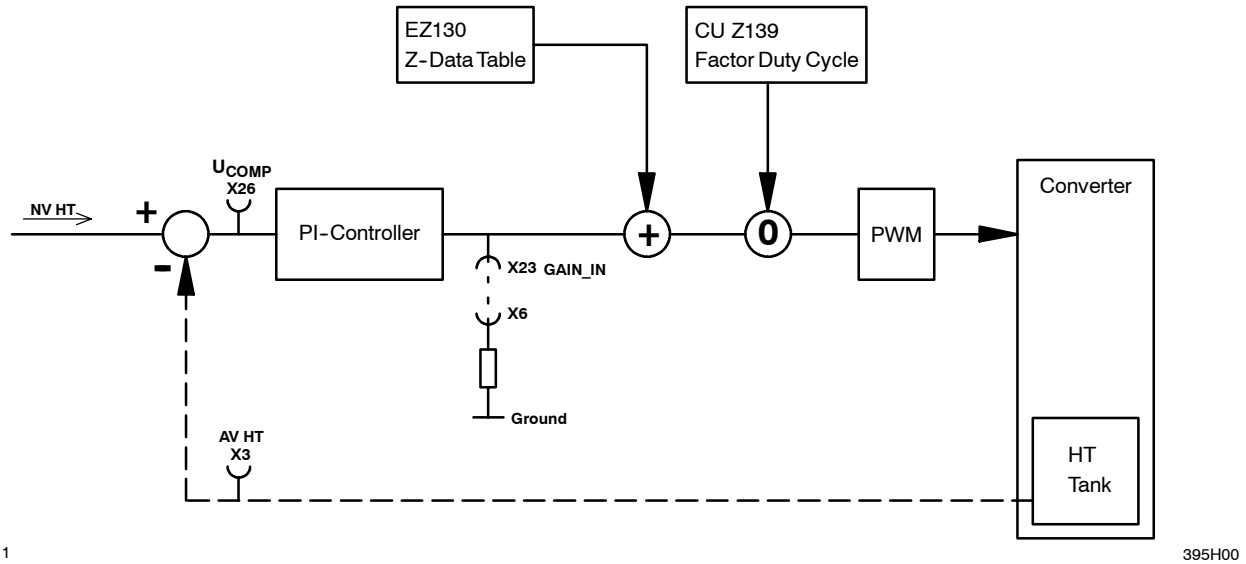


Figure 1 395H00

During alignment this Factor Duty Cycle must be entered via XRGSCOPE. The influence of this factor as a correction value for the Z-Data Table is monitored as the $U_{COMP}$ signal, since the PI-Controller is deactivated by the grounded *GAIN_IN* signal.


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## 1.2. Connecting and setting the scope

For connections see figure 2:

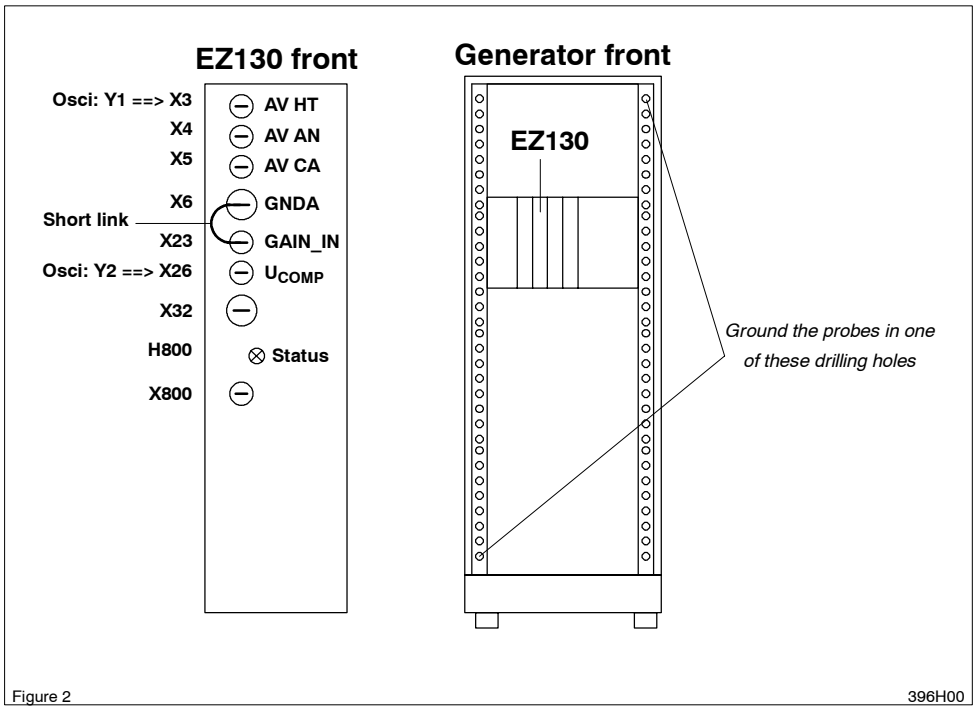


Figure 2 396H00

Channel 1 = EZ130 X3 ---> *AV HT* ---> 20kV/V ---> 1V/div --> Zero-line at bottom of screen
Probe GND = one of the drilling holes at the front cabinet chassis

Channel 2 = EZ130 X26 ---> $U_{COMP}$ ---> 1V/div ---> Zero-line 2 div from bottom of screen
Probe GND = one of the drilling holes at the front cabinet chassis

Trigger = external (preferred) ---> *CTRL_X_C/* ---> backpanel EZX74 / negative slope
or = internal channel 1 ---> *AV HT* ---> EZ130 X3 / positive slope at +3V
Probe GND = one of the drilling holes at the front cabinet chassis

Time base = 5 or 10ms/div ---> trigger delay -1div

**Note**
*A digital scope should not have any other ground connection than the ground of the 3 probes at the drilling holes at the front generator chassis.*
*A mains driven scope must be isolated from earth potential, otherwise it might display artefacts.*


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## 1.3. Deactivating the kV controller

- Connect EZ130 X23 *GAIN_IN* and X6 *GNDA* with a short link (use a short wire).

### Caution!

**This alignment requires exposures with high kV.**
**Be sure the tube has been warmed up before.**

## 1.4. Setting of exposure data

**a) Set 141kV in case of**

- 65/80kW
- the tube limit (of at least one tube) is 150kV perform this adjustment at the tube which has the highest kV limit programmed.

**b) Set 125kV in case of**

- 50kW

  and
- 65/80kW if the programmed application limit of the tube limit is 125kV.

**Note**

*Any tube arcing during this adjustment requires the execution of the tube conditioning next as described in section 2 "INSTALLATION".*
*Disconnect the short link between X23 and X6.*
*Start over this adjustment from chapter 2.3 onwards if the tube conditioning was successful.*

- Set kV and mA values according to the programmed tube limits:

| | | | | |
|---|---|---|---|---|
| **a) 141kV:** | 200mA | at | kV_4 | (65/80kW) |
| **b) 125kV:** | 100mA | at | kV_3 | (50kW) |
| | 200mA | at | kV_4 | (65/80kW) |

- Set exposure time: 40ms


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## 1.5. Adjustment of the ”factor for duty cycle”

- Adjust the Factor Duty Cycle via service software XRGSCOPE by measuring $U_{COMP}$ with the scope.
- Connect the service PC and start XRGSCOPE:
  XRGSCOPE
  SELECT UNIT ---> FU-kV ---> ADJUST ---> IGBT Pulse Width Correction ---> Factor Duty Cycle
- Set the starting value Factor Duty Cycle to **1.00**:

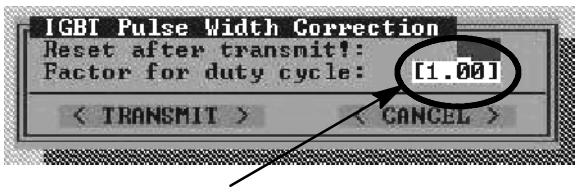
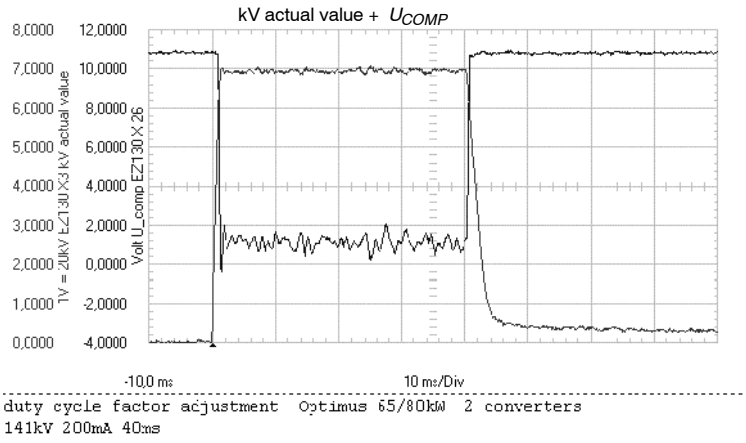


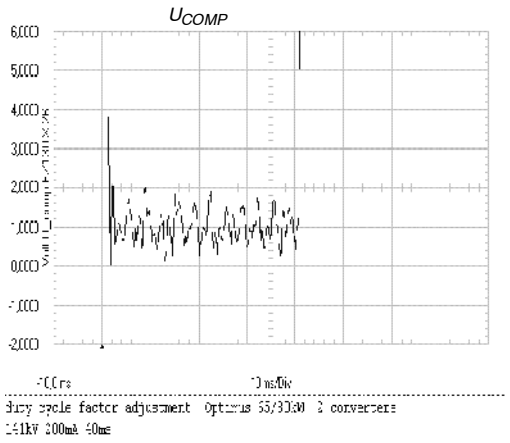

Figure 3 397H00

- If the $U_{COMP}$ value does not match the requirements type in another Factor Duty Cycle value, <TRANSMIT> the screen and push the active RGDV button to get the new value validated.
- Switch an exposure.
  The values are measured in the stationary condition. The transient behavior at the beginning of the exposure is not taken into account.

**Result**: In standby the $U_{COMP}$ value is at about +11V, during exposure the mean value $U_{COMP}$ must be as given in table 1 or 2, refer to figure 4:




Oscillogram of a perfect alignment for 141kV




$U_{COMP}$ for 141kV

Figure 4 401H00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**a) 141kV setting (65/80kW only)**

- Read the mean value of $U_{COMP}$ for 141kV (see scope figure 4 or 5), correct the Factor Duty Cycle till $U_{COMP}$ meets the required reference of +1V.

| kV setpoint | mA setpoint | PCB type | $U_{COMP}$ | Tolerance | kV peak of *AV HT* | Factor Duty Cycle: | Date: |
|---|---|---|---|---|---|---|---|
| 141kV | 200mA | PCB kV_control 4: | +1V | ±0.5V | 138kV | | |

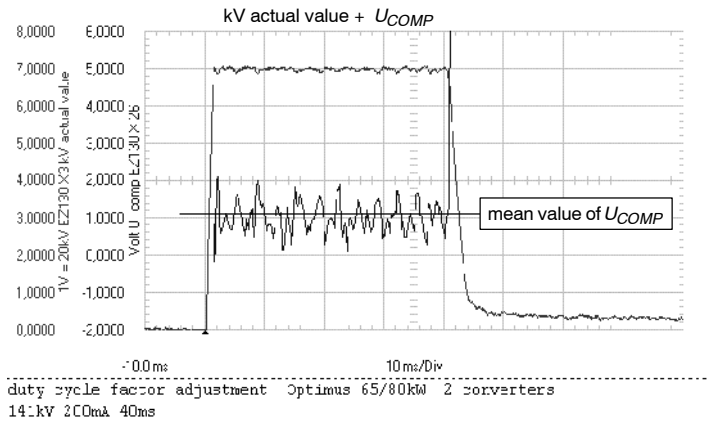
Table 1: Factor Duty Cycle, settings 141kV (150kV limit)

Example how to correct the Factor Duty Cycle:

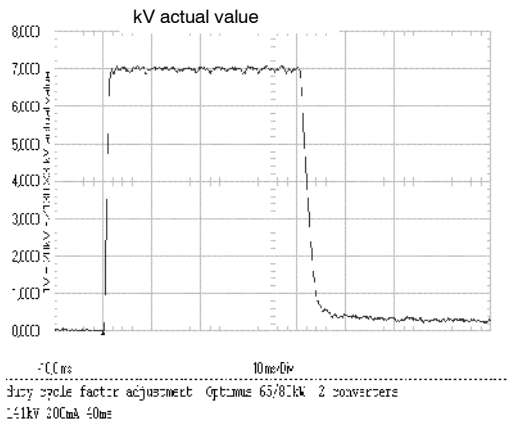
**PCB kV_control 4:**

- If the mean value of $U_{COMP}$ is: > +1.5V **increase** the Factor Duty Cycle in steps of 0.01
  < +0.5V **decrease** the Factor Duty Cycle in steps of 0.01

- Check also the kV peak value *AV HT* (not the overshoot), it must be **138kV** for **141kV** setpoint. (see scope figure 5)
- Remove short link EZ130 X23 *GAIN_IN*.
- Record the findings in table1.




Optimus 80kW with 141kV, $U_{COMP}$ = +1V




*AV HT* with overshoot

Figure 5 402H00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**b) 125kV setting (50/65/80kW)**

- Read the mean value of $U_{COMP}$ for 125kV (in principle figure 4 or 5).
- Correct the Factor Duty Cycle till $U_{COMP}$ meets the required reference of 0V.

| kV setpoint | mA setpoint | PCB type | $U_{COMP}$ | Tolerance | kV peak of *AV HT* | Factor Duty Cycle: | Date: |
|---|---|---|---|---|---|---|---|
| 125kV | 100mA | PCB kV_control 3: | +0V | +1V / -0,5V | 125kV | | |
| 125kV | 200mA | PCB kV_control 4: | +0V | ±0.5V | 125kV | | |

Table 2: Factor Duty Cycle, 125kV limit

Example how to correct the Factor Duty Cycle:

**PCB kV_control 3:**

- If the mean value of $U_{COMP}$ is: > +1V **increase** the Factor Duty Cycle in steps of 0.01
  < -0.5V **decrease** the Factor Duty Cycle in steps of 0.01

**PCB kV_control 4:**

- If the mean value of $U_{COMP}$ is: > +0.5V **increase** the Factor Duty Cycle in steps of 0.01
  < -0.5V **decrease** the Factor Duty Cycle in steps of 0.01

- Check also the kV peak value *AV HT* (not the overshoot), it must be **125kV** for **125kV** setpoint.
- Remove short link EZ130 X23 *GAIN_IN*.
- Record the findings in table 2.


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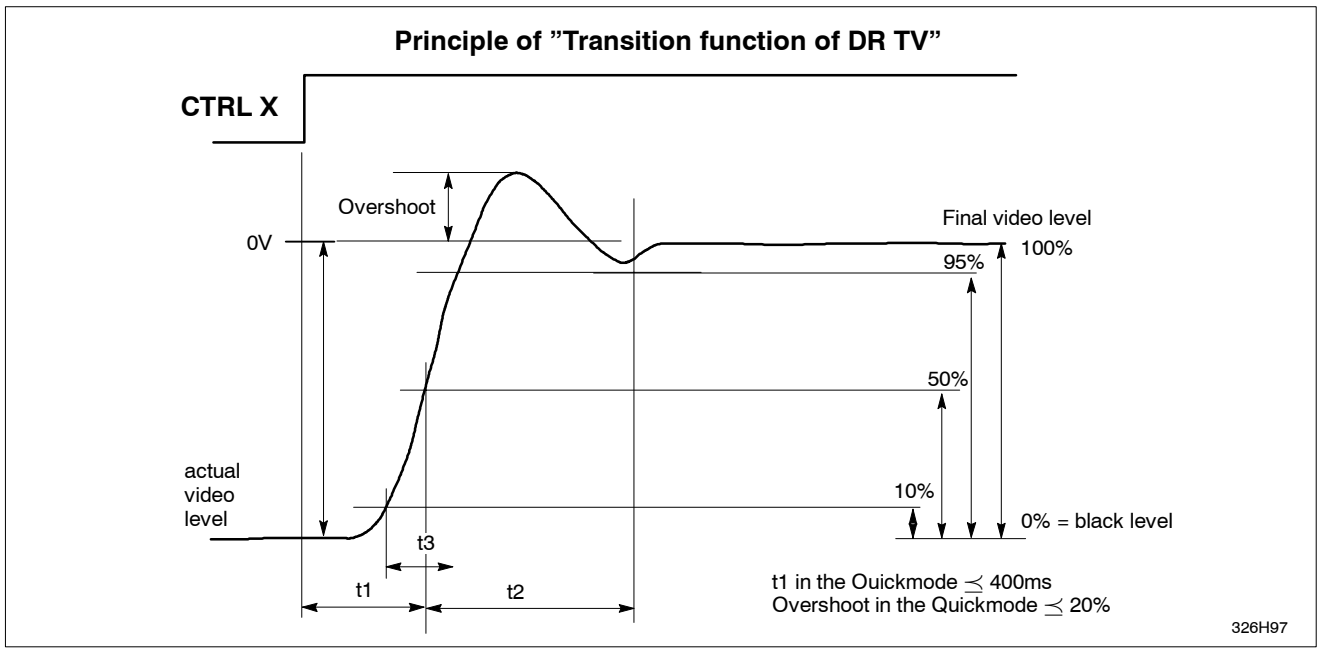
# 2. Dose rate alignment for continuous fluoroscopy when using the dose-rate signal DR TV (formerly ADC) // dose-rate control via TV-chain

## 2.1. Aim

The amplification factor of the control circuit must be adjusted such that
- the TV image becomes visible within about 400ms after fluoroscopy is switched ON with RQXGFL
- there is no flashing of the TV image (overshoot < 20%).

Also see sketch below:





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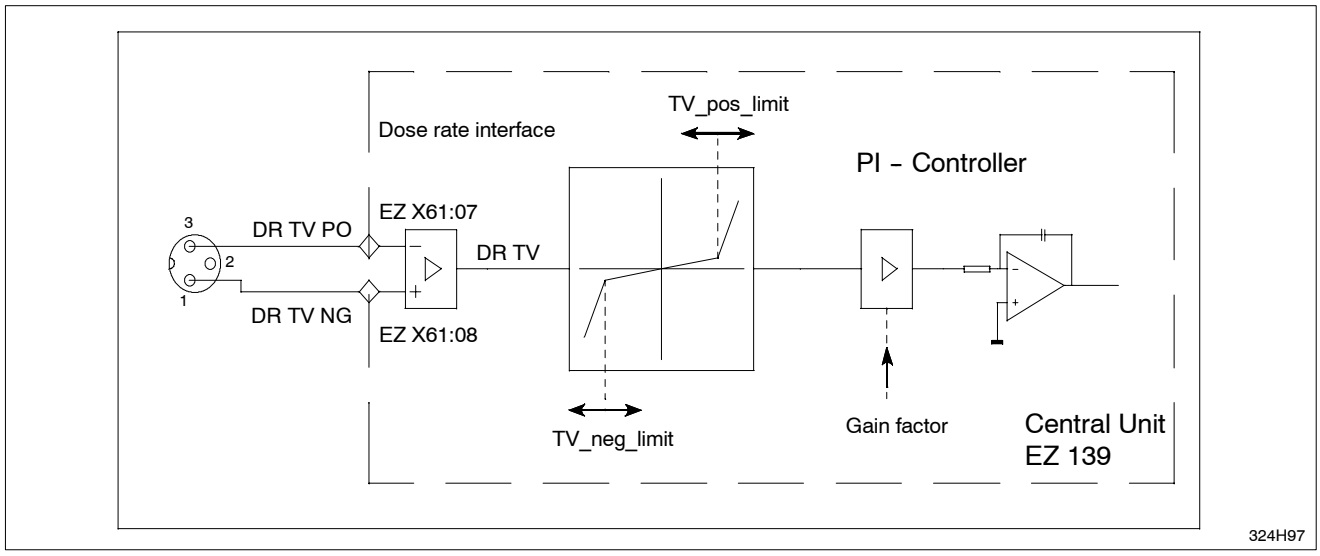
## 2.2. Principle

Adjusting value : Transition function of DR TV
Variables : TV_pos_limit / TV_neg_limit / Gain factor




- Set the gain factor to default value = 1.00 with FW XRGSCOPE:

  OPTIMUS
  --> Adjustments
  --> Dose rate control
  --> Amplification gain
  --> CONT **Gain factor 0.5...2 (default = 1): [1.000]**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- With fluoroscopy **switched OFF**, measure the black level of the dose-rate signal of the TV chain.
  Suitable test points:
  - WN 25 DRDFP (with a TV chain XTV 11)
  - (EZ X61:7 = DR TV PO)

  The kink of the characteristic curve TV_pos_limit to be adjusted must be:
  TV_pos_limit = DR TV PO (black level measured) – 500mV
  **Example:** DR TV PO = 7.3V → adjusting value TV_pos_limit = 6.8V

- Set TV_pos_limit via XRGSCOPE:
  OPTIMUS
  --> Program
  --> Dose rate control
  --> **CONT:**

Program settings for continuous fluoroscopy:

```
+ ---------- CONT_MOD.TDL ---------- +
| scantime_TV [ms]:   [ 20.000] |       → 50Hz = 20ms
| scantime_TV valid:      Yes❑  |       → yes with control via TV chain.
|                               |         With photo diode = no.
| P_max_EDL [W]:       [  250]  |       → 250 default: Effective only when SID
|                               |         WB X12:1 DRLM is switched ON.
| TV_pos_limit [V]:     [6.8]   |       → DR TV PO - 500mV.
|                               |         (TV black voltage - about 500mV)
| TV_neg_limit [V]:     [-6.8]  |       → = - TV_pos_limit [V]
| ------------------------------- |
|   < OK >                      |
| ------------------------------- |
```

In case the switch ON procedure is fast enough with this setting
T1 ≦ 400ms in quick mode or T1 ≦ 500ms in normal mode
and the TV chain does not flash when fluoroscopy is switched ON,
overshoot ≦ 20%
the alignment with the oscilloscope described below is **not** required.


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## 2.3. Alignment of DR TV with the oscilloscope

**Settings of the oscilloscope:**

| | | | | |
|---|---|---|---|---|
| Y1 | to EZ 150 X6 | : | EN X C/ | [10V/div] |
| Y2 | e.g. with XTV11 to WN 25 | : | DRDFP | [ 5V/div] |
| Ground | to EZ 150 X5 | : | GNDA | |
| Time base | | : | 200ms/div | |
| Trigger | | : | Y1 / - DC | |

The alignment should not be carried out in the quick mode since the differences of the transition functions are not big enough in the quick mode. However, in the normal mode the overshoot is slightly higher than 20%.

Since fluoroscopy is automatically in the quick mode for up to 30s after the end of fluoroscopy, after each oscillogram fluoroscopy must be switched OFF for at least 30s:

Pause > 30s → Fluoro ON → Oscillogram → Fluoro OFF
→ Pause > 30s → Fluoro ON → Oscillogram → Fluoro OFF
→ ...

**Fluoroscopy adjustments for all oscillograms:**

- Dark voltage of the TV chain measured: DR TV $PO_{dark}$ = 7.3V

**XRGSCOPE:**

OPTIMUS
--> Program
--> Dose rate control
--> **CONT:**

```
scantime_TV [ms]      : 20.000  (→ 50Hz)
scantime_TV valid     : Yes
P_max_EDL [W]         : 250
```

**Operating point of fluoroscopy in the automatic mode (example XTV 11):**

- 9" I.I. format
- Filter in the path of radiation: 1.5mmCu + 20mmAl ==> 74kV / 2.2mA


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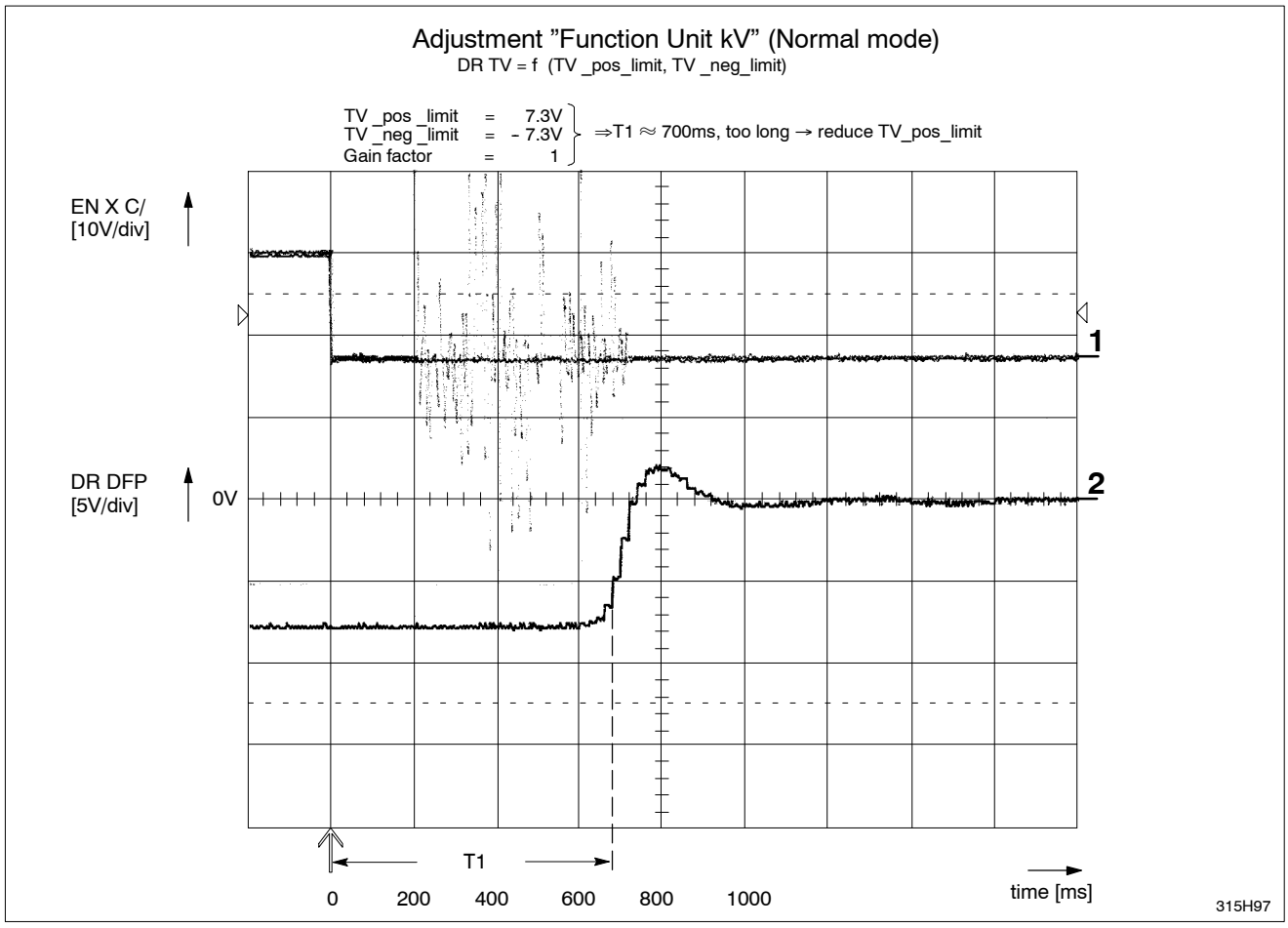
**First reference oscillogram:**

Values adjusted with XRGSCOPE:

- TV_pos_limit [V] : [ 7.3 ]
- TV_neg_limit [V] : [-7.3 ]
- Gain factor : [ 1.00]

} ==> T1 ≈ 700ms --> too long --> reduce TV_pos_limit [V]





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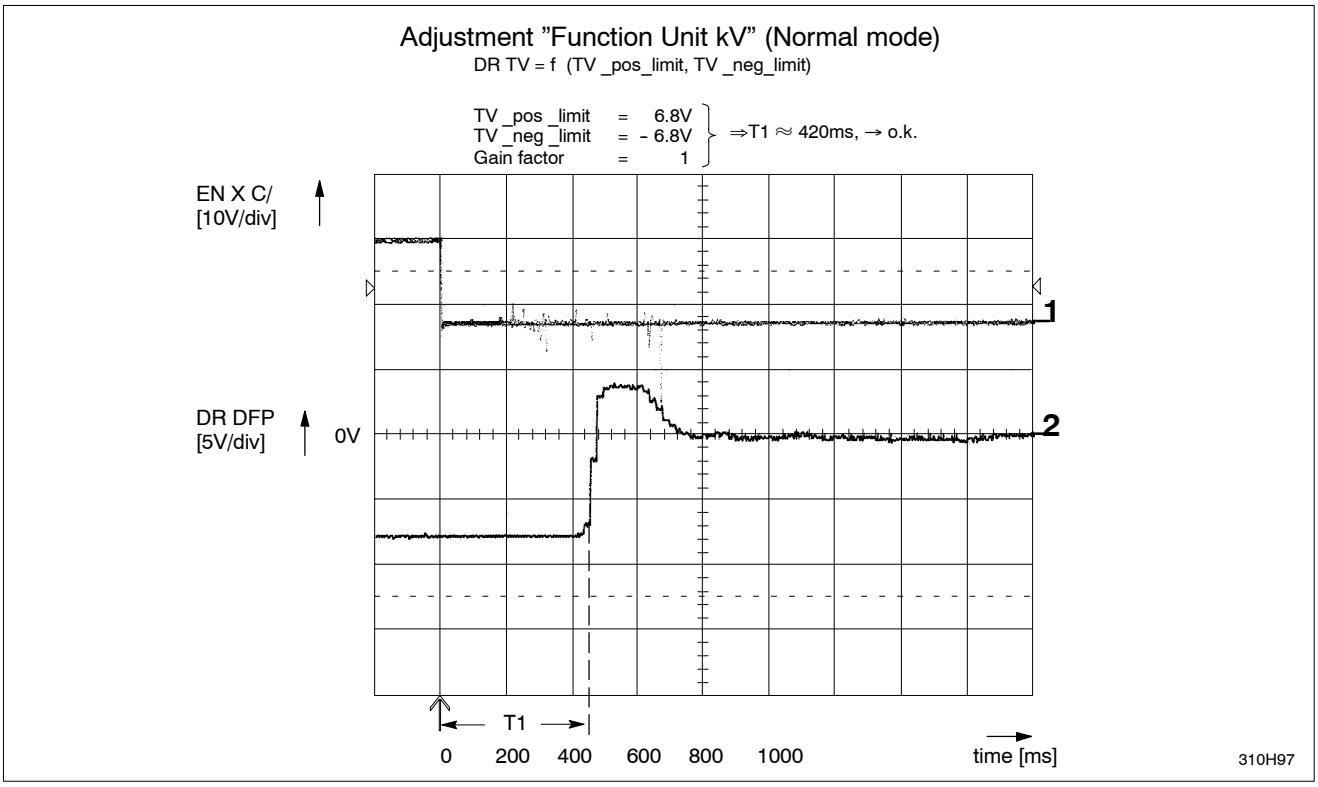
**Second reference oscillogram:**

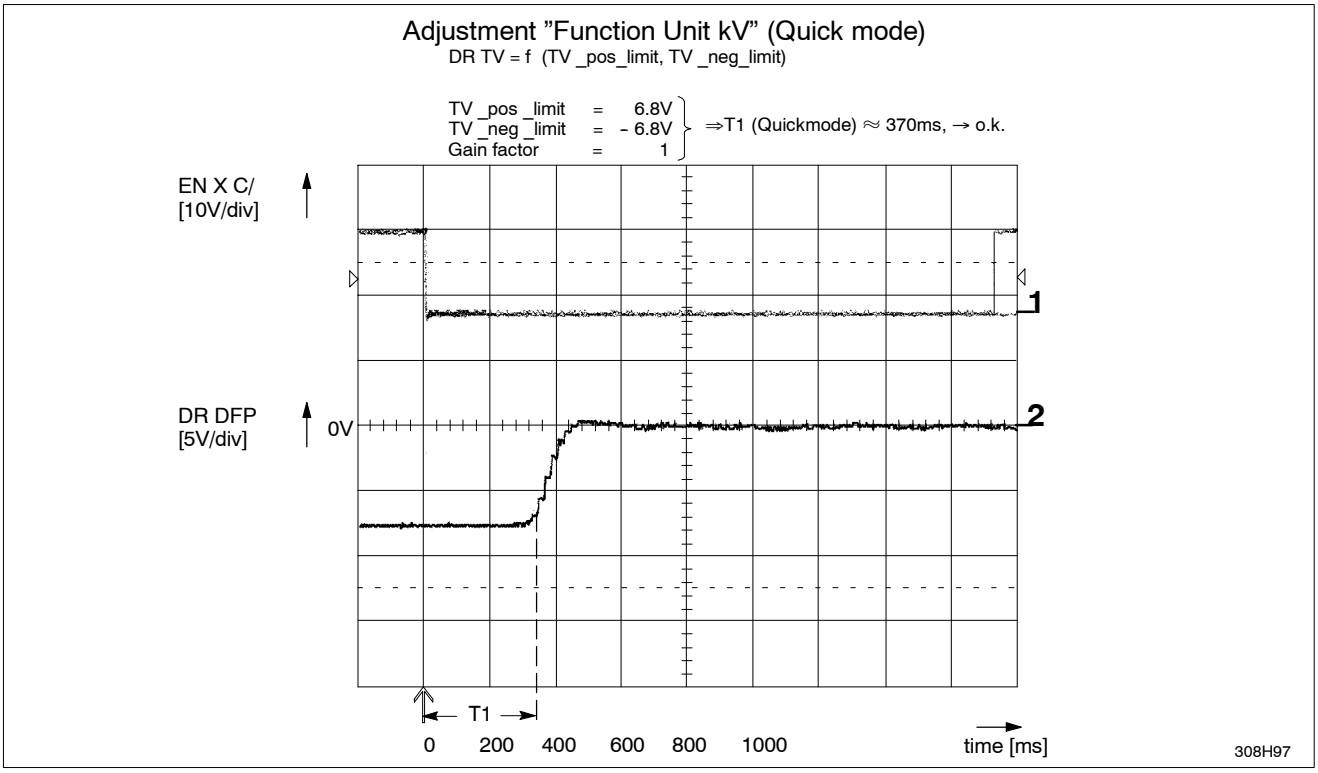
Values adjusted with XRGSCOPE:

- TV_pos_limit [V] : [ 6.8 ]
- TV_neg_limit [V] : [-6.8 ]
- Gain factor : [ 1.00]

==> T1 ≈ 420ms --> o.k.

and gain factor can remain as they are





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**Third reference oscillogram:**

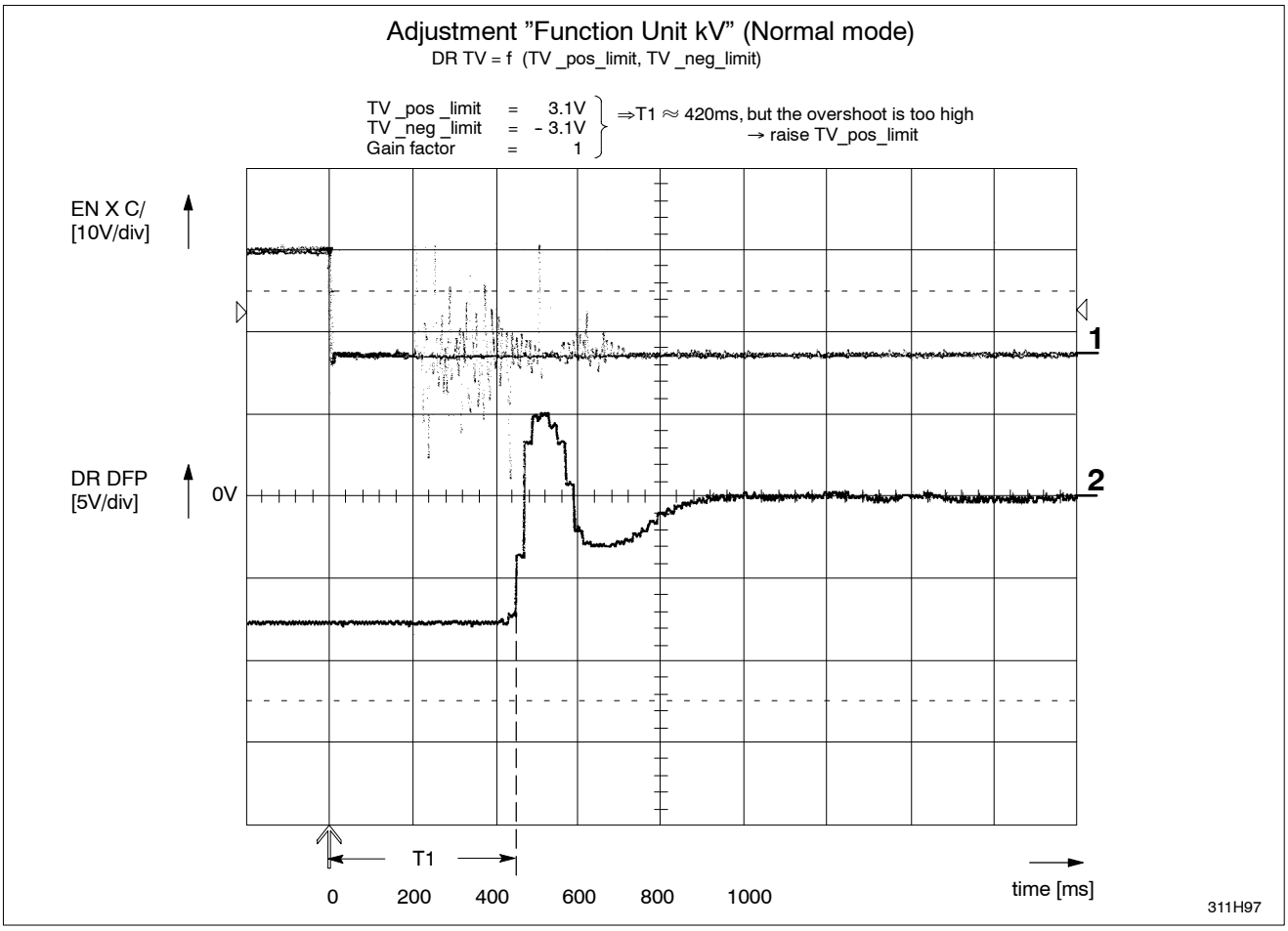
Values adjusted with XRGSCOPE:

- `TV_pos_limit [V] : [ 3.1 ]`
- `TV_neg_limit [V] : [-3.1 ]`
- `Gain factor : [ 1.00]`

==> T1 ≈ 420ms --> o.k., but the overshoot is too high

The TV image flashes!

--> `Raise TV_pos_limit [V]`





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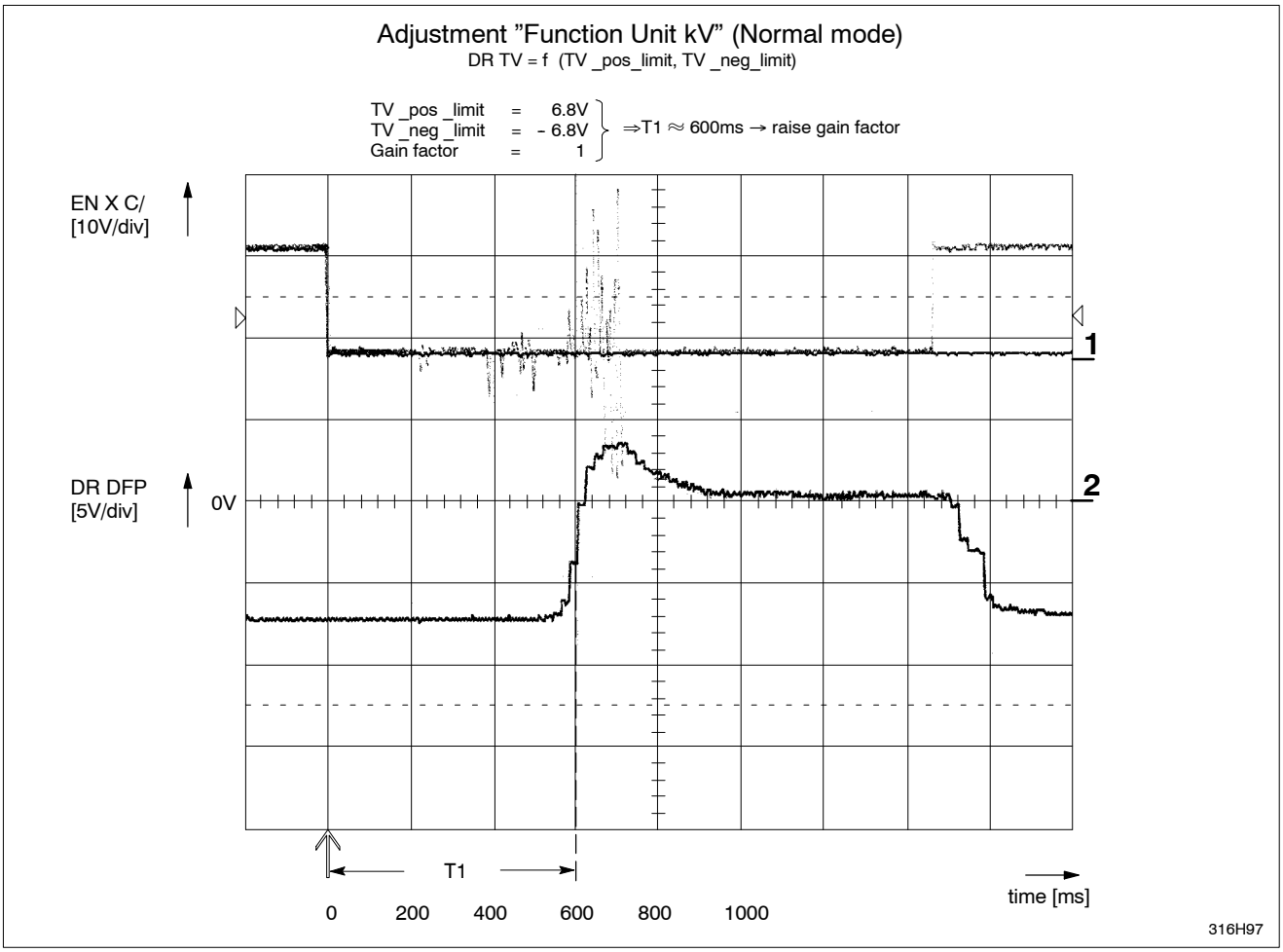
**Forth reference oscillogram:**

Values adjusted with XRGSCOPE:

```
- TV_pos_limit [V]   :  [  6.8]
- TV_neg_limit [V]   :  [ -6.8]   } ==> T1 ≈ 600ms --> too long --> Raise gain factor to 1.00!
- Gain factor        :  [0.50 ]
```





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# 3. Maximum patient entrance dose rate: Entrance Dose rate Limiter (EDL)

## 3.1. Aim

In some countries the maximum patient entrance dose rate must be limited to comply with the respective national regulations, for instance 10R/min = 1.4567μGy/s in the USA.

## 3.2. Principle

The maximum patient entrance dose is measured with maximum kV. By reducing the maximum power P_max_EDL provided by the generator, the dose rate is reduced until it complies with the national regulations or the individual wish of the user.

**Note**
*The dose rate reduction programmed via P_max_EDL is effective only when the SID contact (**S**ource **I**mage **D**istance) is switched ON: WB X12:1 DRLM → closed!*

## 3.3. Alignment

- Cover the I.I. with lead such that with fluoroscopy maximum kV (110kV) are adjusted (protection of the I.I. against excessive radiation).
- Adjust the exam./aux. unit in such a way that the SID contact is closed.
  If necessary, place a shorting plug on decade: WB X12:1 <----> X12:10 (ground).
- Adjust the exam./aux. unit in such a way that the smallest distance between tube and patient is effective.
- Position the dose rate measuring chamber in such a way that it is at the same height where the radiation would enter the patient.
- Switch ON fluoroscopy.
- Reduce/raise **P_max_EDL [W]** with the service software XRGSCOPE until the dose rate is identical with the maximum permissible value:

XRGSCOPE OPTIMUS
--> Program
--> Dose rate control
--> **CONT:**

```
+ ---------- CONT_MOD.TDL ---------- +
| scantime_TV [ms]:   [ 20.000]      |
| scantime_TV valid:      Yes        |
|                                    |
| P_max_EDL [W]:       [ nnn]        |
|                                    |
| TV_pos_limit [V]:     [6.8]        |
|                                    |
| TV_neg_limit [V]:     [-6.8]       |
| ---------------------------------- |
|   < OK >                           |
| ---------------------------------- |
```

Range: 0 ... 9000W (250 default)
→ Effective only when SID contact WB X12:1 DRLM is switched ON.


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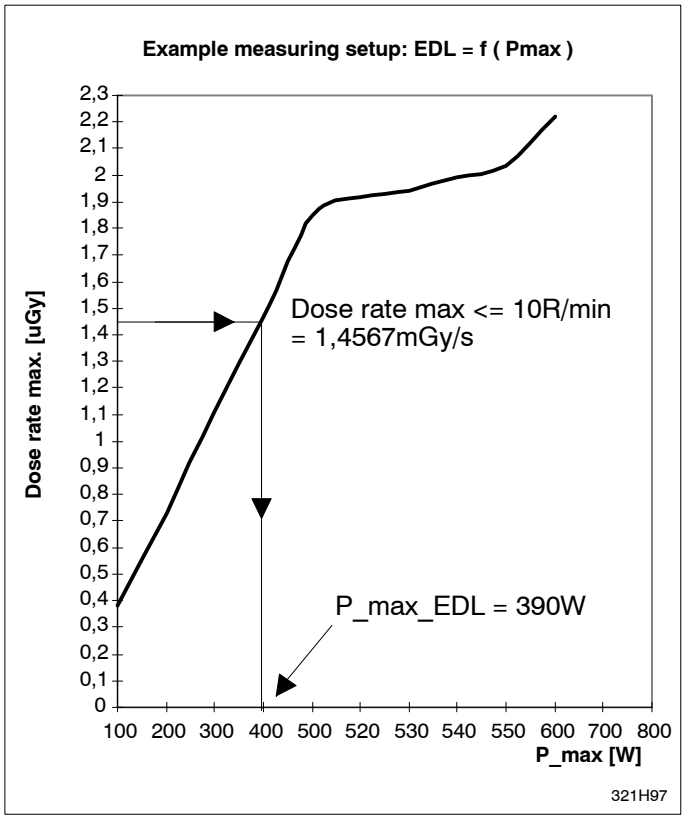
- Note the measuring values:

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P_max_EDL: [W] | | | | | | | | | | | | | | |
| Dose rate: [µGy/s] | | | | | | | | | | | | | | |

Example of a measuring setup:





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# ACCEPTANCE

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**3. Setup** ..... 7-1

**4. Test** ..... 7-2

**5. Exposure counter** ..... 7-3



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# 1. Preface

The national rules for accepting an X-ray system are very different. Therefore in the following an example is given for checking the generator in the USA.

OPTIMUS generators are factory-calibrated and checked for compliance with the parameter readout tolerances as stated in the relevant Operator's Manuals.

Provided that these generators are installed and set to work in accordance with the Installation Manuals, only the following limited field compliance testing is required.

# 2. Test equipment

- Keithley voltage divider model No. 35080 with filter packs 32867C, 5C, 9C or equivalent
- Oscilloscope (storage)
- Digital mA, mAs meter

**Note**

*Do not start test until generator has been switched ON for at least one hour.*

*Direct (invasive) kVp measurements on OPTIMUS generators with HV divider tanks normally available to the field service organization are not permitted.*

*Measurements of kV using instruments other than the Keithley instrument may lead to larger measuring tolerances. The causes are to be found in the specific frequency response and transient response of each test instrument.*

# 3. Setup

- Switch OFF generator and also switch OFF mains.
  Disconnect breaker to system.
- Connect digital mA meter as per instructions in the relevant Service Manual.
- Set up the Keithley voltage divider complete with the appropriate filter as per Keithley Instructions Manual No. 3294 OIM.
- Connect the oscilloscope to the Keithley divider.

  **Note**
  *Make sure that the oscilloscope has been calibrated with the aid of the Keithley divider as described in the Keithley Instructions Manual before starting any testing (par. 3.6. Internal Calibration).*

- Calculate rejection limits based on the exposure parameter "Specification Limits" shown in the table below.

  The "Specification Limits" are based on the actual tolerances as listed in the generator Operator's Manuals. These "Specification Limits" must be restricted to include the actual measuring instrument error.
  See also section 6, chapter 3.2 of the "COMPREHENSIVE COMPLIANCE TESTING MANUAL", No. 4535 800 2034x. regarding how to calculate rejection limits.


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# 4. Test

- Switch the system ON.
- Measure the mains voltage on ENF1.

  Reference voltage: Mains voltage programmed ±10%

  Actual values: L1 – L2: ..... V

  L1 – L3: ..... V

  L2 – L3: ..... V

- Select the largest focus.
- Release exposures according to the table below and compare the values measured with the reference values.

| Technique | Parameter | Reference range | Measured value | Corrected value |
|---|---|---|---|---|
| 3–knob technique | 81kV ±5% ±1kV | 76 ... 86kV | ..... kV | — |
| | 250mA ±5% ±0.5mA | 237 ... 263mA | ..... mA | ..... mA |
| | 100ms ±5% ±0.5ms | 94.5 ... 105.5ms | ..... ms | — |
| 2–knob technique | 125kV ±5% ±1kV | 118 ... 132kV | ..... kV | — |
| | 80mAs ±3% ±0.5mAs | 77.1 ... 82.9mAs | ..... mAs | ..... mAs |

Owing to an offset current in the measuring circuit of the HV generator the measured values for mA / mAs must be adjusted using the following formulas:

$$I_{corrected}\ [mA] = I_{measured}\ [mA] - \frac{U\ [kV]}{R_{calc}\ [M\Omega]} \qquad \text{Offset} \approx 0.2 \ldots 0.75mA$$

$$Q_{corrected}\ [mAs] = Q_{measured}\ [mAs] - \frac{U\ [kV] \times t\ [s]}{R_{calc}\ [M\Omega]} - \underbrace{\frac{4.55\ [nF] \times U\ [kV]}{1000}}_{\text{Cable charge for 20m HV cable}}$$

**$R_{calc}$** = calculated measuring circuit resistance.
Typical value: ≈ 200MΩ
Read out $R_{calc}$ via service menu: FU_MA/ FAULT FIND/ **READ $I_e$ CORRECTIONS**
Focus assignment: Focus 1 = tube 1 large focus
2 = tube 1 small focus

**t** = exposure time according to Cockpit display


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# 5. Exposure counter

Before handing over the generator to the customer, read the exposure counter.
Use menu:
ACCEPT/ INSPECT/ TUBE STATISTIC/ TUBE 1 ... 3 STATISTIC/ **SHOW TUBE STATISTIC**
Record the figure in the table below.

| Tube load statistic variable | Unit | Tube |
|---|---|---|
| Reset date | dd.mm.yy | |
| Last update | dd.mm.yy | |
| Preparation time large focus | s | |
| Preparation time small focus | s | |
| Preparation time vario focus | s | |
| Preparation counter large focus | 1 | |
| Preparation counter small focus | 1 | |
| Preparation counter vario focus | 1 | |
| Fluoro time | min | |
| Fluoro counter | 1 | |
| Exposure counter large focus | 1 | |
| Exposure counter small focus | 1 | |
| Exposure counter vario focus | 1 | |
| Overload exposures counter large focus | 1 | |
| Overload exposures counter small focus | 1 | |
| Overload exposures counter vario focus | 1 | |

The table should be reset whenever the tube is being replaced.
Use menu:
ACCEPT/ INSPECT/ TUBE STATISTIC/ TUBE 1 ... 3 STATISTIC/ **RESET TUBE STATISTIC**
Record the figure in the table above.


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**Explanation:**

**Reset date** / **Last update:**
Reset date and date of last update of the tube statistic.

**Preparation time:**
The sum of all preparation times per focus.

**Preparation counter:**
Counts the occurrences of transition STANDBY or FLUORO to PREPARATION per focus.

**Fluoro time:**
The sum of all fluoro times.

**Fluoro counter:**
Counts the fluoro commands.

**Exposure counter:**
Counts the exposures per focus (including the overload exposures).

**Overload exposures counter:**
Counts the exposures at overload conditions of the tube.


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# Schematic drawings

## Basis

Block diagram basis . . . . . Z1-1.1

Power supply . . . . . Z1-2.1
Power supply with mains transformer (WT) . . . . . Z1-2.2
Low voltage power supply . . . . . Z1-2.3

kV control . . . . . Z1-3.3

mA control . . . . . Z1-4.1
H.V. generator . . . . . Z1-4.2

Central unit . . . . . Z1-5.1

Basic interface . . . . . Z1-6

## Options

Dual speed rotor control
9890 000 0268x . . . . . Z1-13.2


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## Function units CU and DRC
(Z1-5)

## Power supply
(Z1-2)

## Function unit kV
(Z1-3)

## Function unit mA_a
(Z1-4)

## Function unit CIE
(Z1-6)

Room decade
Cooling unit
Measuring chamber 1 2 3 4 5
EZ X1 · EZ X2 · EZ X21 · EZ X22 · EZ X31 · EZ X32 · EZ X41
X1 X1 X1

Service PC — X5

**EZ139**
Central unit CU
Dose rate control DRC

EZX61
DRC input — X1

X1/X2 X1/X2

**EZ102**
Low voltage supply

X1 X2

5V
-15V
+15V
26V

**EZ130**
kV Control

X1 X2 X1 X1

**EZ119**
mA Control

X1 X1 X1/X2

**EZ150**
Basic interface

X1/X2

External signal bus — EZX23 — XS bus — XS bus

Function programming plug
- system control
- desk control

System CAN — EZX42 ✳ EZX43 — CAN — EZX44

XRG bus

EZX46

XS-bus — External XS-bus + internal CAN — EZX45

XRG-bus

Internal expansion

Internal CAN/XS-bus — EZX62 ✳

26V 230V ~ 26V

EZX6 EZX20 EZX13 EZX17 EZX18 EZX19

Adapter for 4 aux. units (option)

EZX34 EZX24

EZX35 EZX12

EZX3

EZX51

100X60 — X110 X111 — CB400

**CB**
Operating panel:
"Cockpit Duo DIAGNOST"

100X10

release switch

EZX47

100X1 100X2 — **E2Q** 2nd power unit for P≥ 65kW — 100X1 100X2 — **EQ** Power unit

X14 X15

**EG**
H.V. generator

X1000 X1000

H.V. cables

3~ 400V

**EY**
Rotor control
LS or HS
(low or high speed)

(no CAN to low speed)

Function unit RC_a

stator supply

supervision

Tube

Function unit HI_a

EZX4:1
Emergency OFF
EZX4:2

F3

100X1 — K1 3~400...480V — X1100 X1100

**EN**
Power supply

F1 F2/K2 F3

EZX14 230V ~ reserve
EZX15 230V ~ reserve
3~400V stand
3~400V rotor control LS/HS

Mains 3~ 400...480V 50/60Hz

Surge arrester WN or Power distribution unit (option)

Remark:
✳ When not used CAN connections EZX42 and EZX45 must be provided with a termination resistor.

A1/A3 02-04-17 Schr.

OPTIMUS C (02.0)

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# Block diagram Basis

Z1-1.1

## Mnemonic's

| | |
|---|---|
| AC0VXG | mains supply 0V X-ray generator |
| AC230VL1 | mains supply 230V AC phase 1 |
| AC230VL2 | mains supply 230V AC phase 2 |
| GND12V | ground +12V supply |
| MNEMOF | mains power emergency off |
| MNON/ | mains on |
| PO12V | +12V supply |
| PWONNG | DC supply relay power on - |
| PWONPO | DC supply relay power on + |
| RDMNON/ | ready mains power on |
| RESETSW/ | system reset |
| SIPHIO | single phase intijicotion |

Wall junction box
MEX
Mains supply
3~400V
50/60Hz
X3201
N
PE
F1 25A
K1
K2
R1 47R
R2 47R
R3 47R
EQX1101 (E2QX1101)
EQX1102 (E2QX1102)
EQX1103 (E2QX1103)
EQ200 X12 (E2Q200 X12)
Discharging circuit
EQ200 X11 (E2Q200 X11)
F2 10A
X3:1
X3:3
T1
230V~
X3:2
H1 gr
low voltage control
K1
S1
V1
100
Power on circuit
X1:6
X1:7
X1:2
X1:1
X2:1
X2:2
X1:9
X1:5
X1:4
T1 X2402
T2 X2403
K2
K1 A1 A2
RC1
X23
F12 10A
Output 3
Imaging
K11
X22
Output 2
II/TV
GECO
SYSCO
NX21
Output 1
Geometry
EN
F11 5A
F3 5A
K11
EM off
X3102
X3101
X3101
X1102
WG 51
WG 57
EZ X13:3
EZ X13:2
EZ X13:1
EZ X14:1
EZ X14:2
EZ X15:1
EZ X15:2
EZ X47:6
EZ X47:7
EZ X47:2
EZ X47:1
EZ X47:9
EZ X47:5
EZ X47:4
EZ X4:1
EZ X4:2
GND 12V
RDMNON/
MNON/
PO26V
GND26V
PWONNG
SIPHIO
PWONPO
EZ X46:15
EZ X46:14
EZ X46:6
EZ X20:1
EZ X20:2
X10:11
X10:4
X10:3
X10:1
X10:15
Logic
off
on
YM
M1 RoCo
GS1:1
M cooler
H.V. generator
G200 X2
Oil circulation pump
H.V. generator
RoCo LS
RoCo HS
WG
Tube extension (option)
EZ119 mA control
EZ102 low voltage supply
EWN second low voltage supply (option)
Adaptation 24V-/230V~
see Z1 :H.V. generator R/F
EZ130 kV control
CB100 Cockpit
Power supply

A2/A3 02-04-30 Schr./Kö


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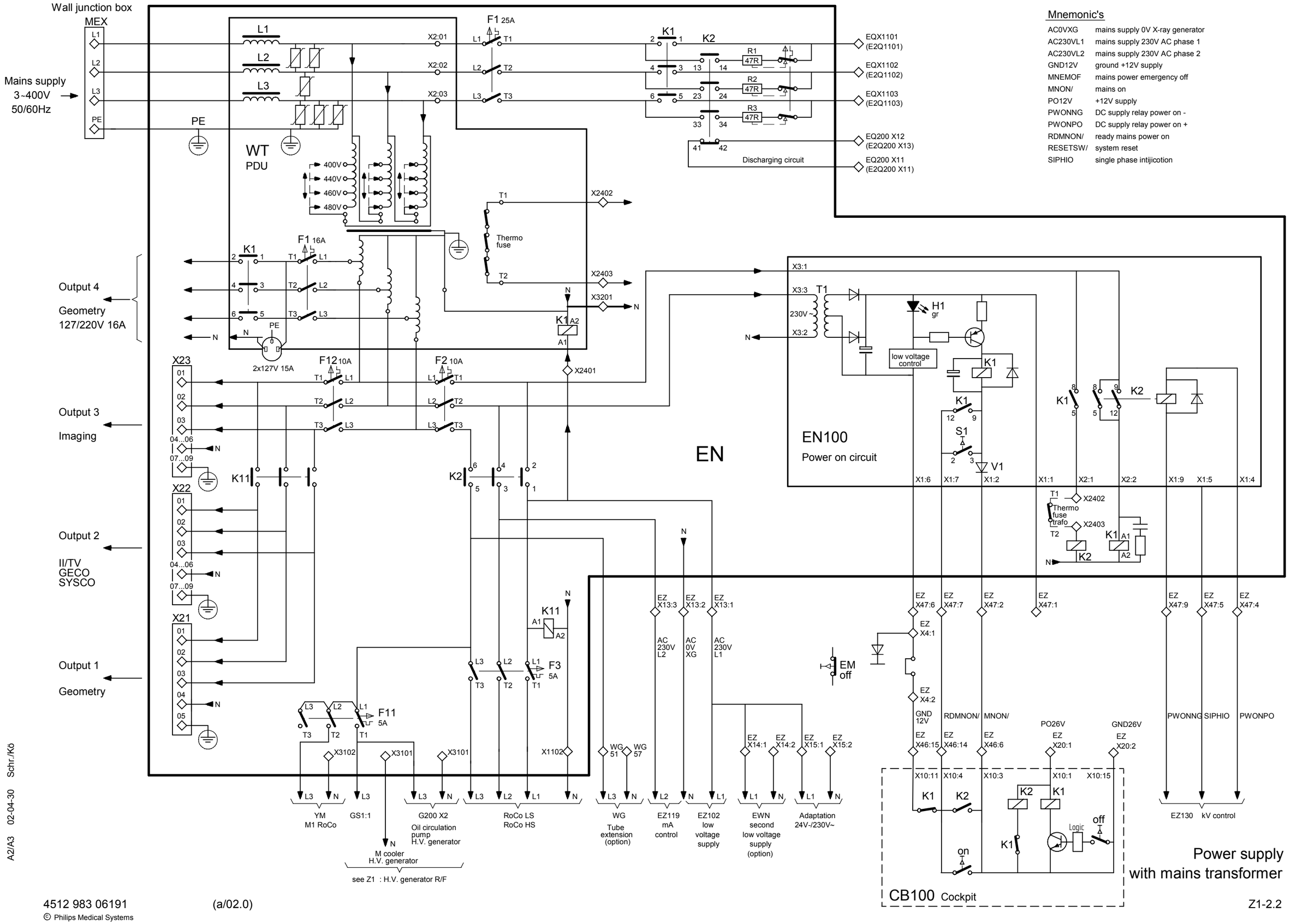


## Mnemonic's

| | |
|---|---|
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| MNON/ | mains on |
| PO12V | +12V supply |
| PWONNG | DC supply relay power on - |
| PWONPO | DC supply relay power on + |
| RDMNON/ | ready mains power on |
| RESETSW/ | system reset |
| SIPHIO | single phase intjicotion |

A2/A3 02-04-30 Schr./Kö

4512 983 06191 (a/02.0)

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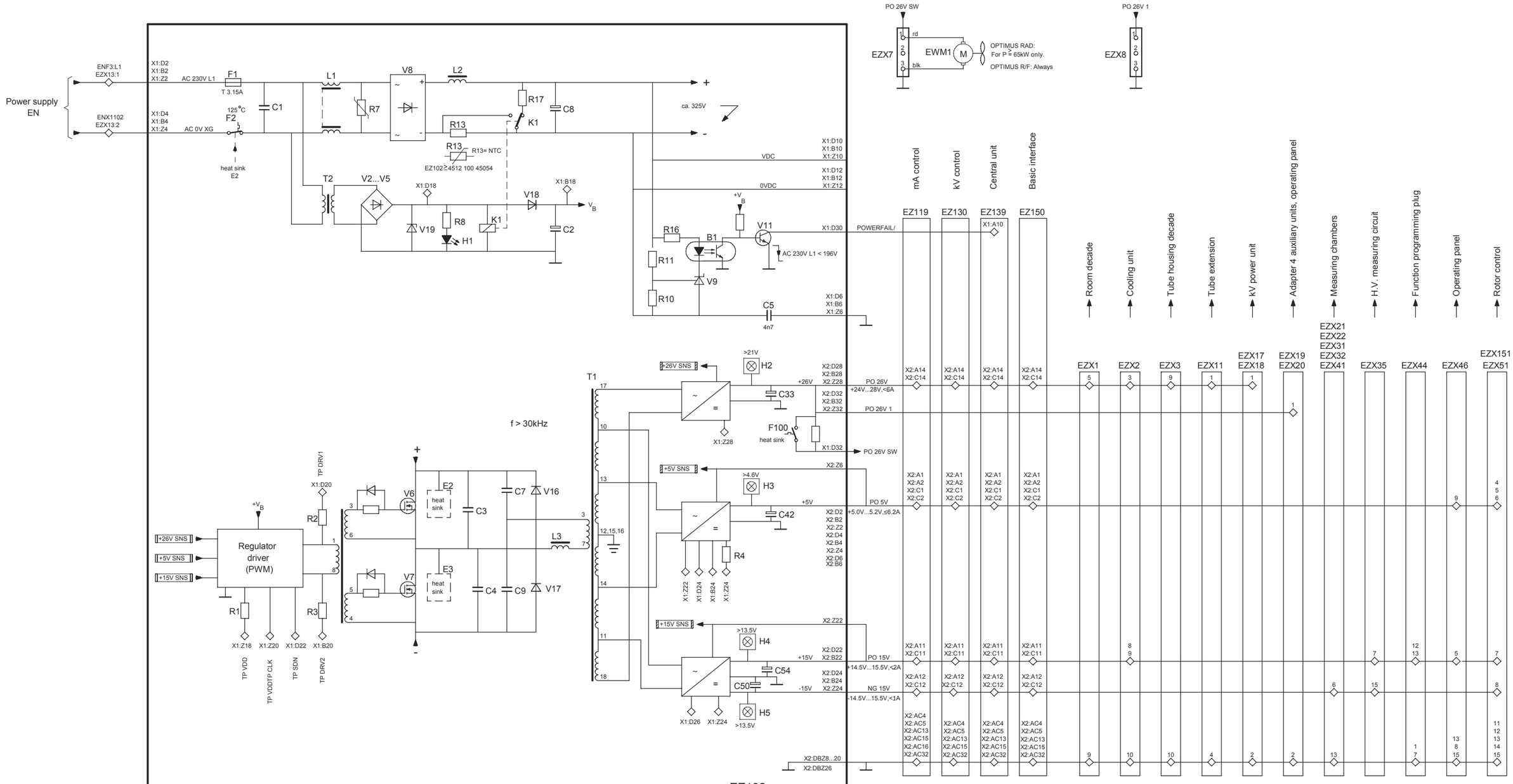


Attention!

The voltage supplies are short circuit proof.
In case of an error refer to selection "Faultfinding".

Mnemonics

| | | | |
|---|---|---|---|
| 0V DC | | TP CLK | test points for internal signals |
| +5V SNS | 5V sense | TP DRV1 | |
| +15V SNS | 15V sense | TP DRV2 | |
| +26V SNS | 26V sense | TP SDN | |
| AC OV XG | mains supply 0V X-ray generator | TP VDD | |
| AC 230V L1 | mains supply 230V AC phase 1 | VDC | |
| NG 15V | -15V supply | | |
| PO 5V | +5V supply | | |
| PO 15V | +15V supply | | |
| PO 26V | +26V supply | | |
| PO 26V1 | +26V supply optional | | |
| PO 26V SW | +26V supply switched | | |
| POWERFAI L/ | power failure reset | | |

# Low voltage power supply

Z1-2.3



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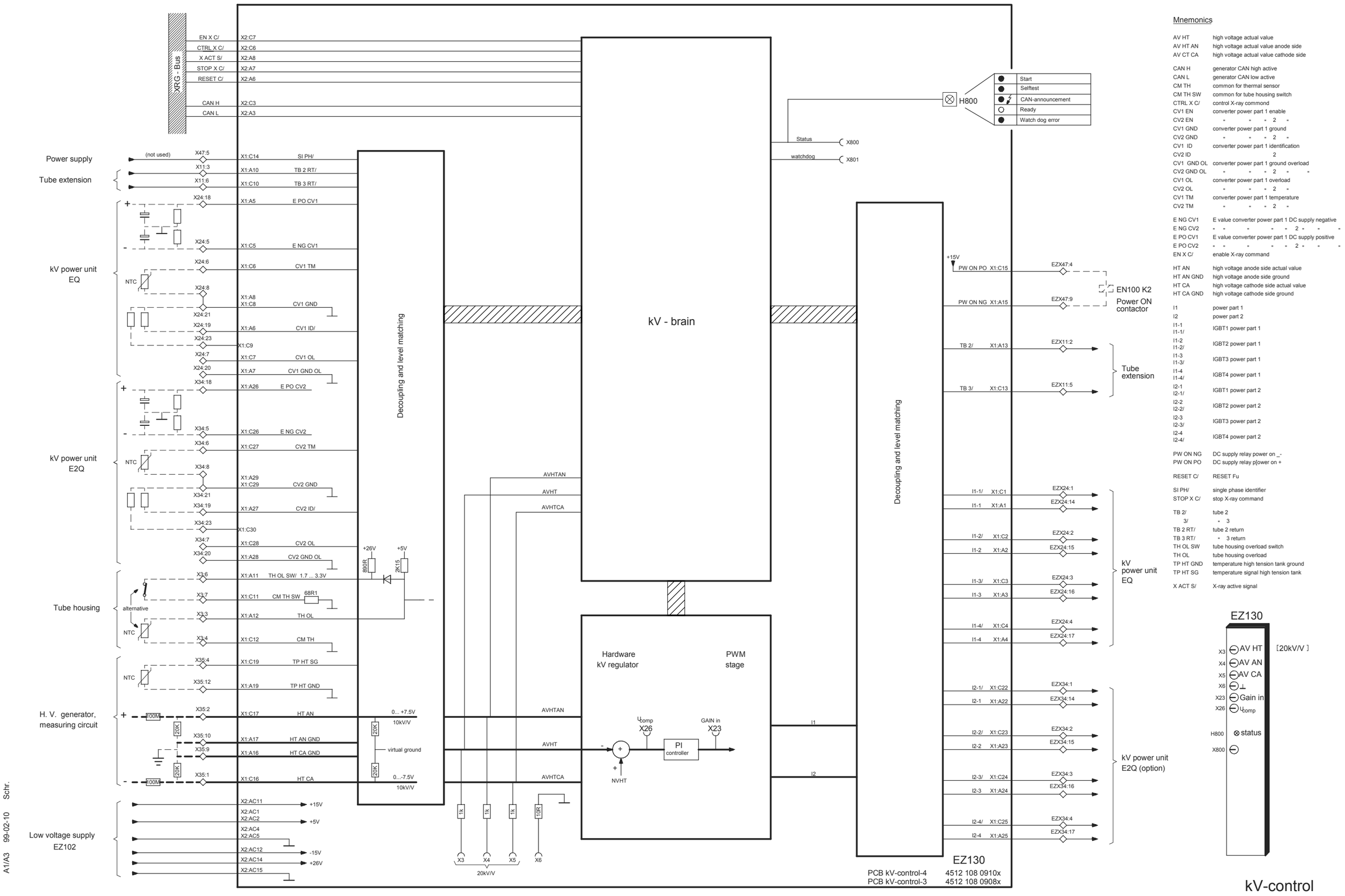


## Mnemonics

| | |
|---|---|
| AV HT | high voltage actual value |
| AV HT AN | high voltage actual value anode side |
| AV CT CA | high voltage actual value cathode side |
| CAN H | generator CAN high active |
| CAN L | generator CAN low active |
| CM TH | common for thermal sensor |
| CM TH SW | common for tube housing switch |
| CTRL X C/ | control X-ray commond |
| CV1 EN | converter power part 1 enable |
| CV2 EN | " " " 2 " |
| CV1 GND | converter power part 1 ground |
| CV2 GND | " " " 2 " |
| CV1 ID | converter power part 1 identification |
| CV2 ID | 2 |
| CV1 GND OL | converter power part 1 ground overload |
| CV2 GND OL | " " " 2 " " |
| CV1 OL | converter power part 1 overload |
| CV2 OL | " " " 2 " |
| CV1 TM | converter power part 1 temperature |
| CV2 TM | " " " 2 " |
| E NG CV1 | E value converter power part 1 DC supply negative |
| E NG CV2 | " " " " " 2 " " " |
| E PO CV1 | E value converter power part 1 DC supply positive |
| E PO CV2 | " " " " " 2 " " " |
| EN X C/ | enable X-ray command |
| HT AN | high voltage anode side actual value |
| HT AN GND | high voltage anode side ground |
| HT CA | high voltage cathode side actual value |
| HT CA GND | high voltage cathode side ground |
| I1 | power part 1 |
| I2 | power part 2 |
| I1-1 I1-1/ | IGBT1 power part 1 |
| I1-2 I1-2/ | IGBT2 power part 1 |
| I1-3 I1-3/ | IGBT3 power part 1 |
| I1-4 I1-4/ | IGBT4 power part 1 |
| I2-1 I2-1/ | IGBT1 power part 2 |
| I2-2 I2-2/ | IGBT2 power part 2 |
| I2-3 I2-3/ | IGBT3 power part 2 |
| I2-4 I2-4/ | IGBT4 power part 2 |
| PW ON NG | DC supply relay power on _- |
| PW ON PO | DC supply relay p[ower on + |
| RESET C/ | RESET Fu |
| SI PH/ | single phase identifier |
| STOP X C/ | stop X-ray command |
| TB 2/ | tube 2 |
| 3/ | " 3 |
| TB 2 RT/ | tube 2 return |
| TB 3 RT/ | " 3 return |
| TH OL SW | tube housing overload switch |
| TH OL | tube housing overload |
| TP HT GND | temperature high tension tank ground |
| TP HT SG | temperature signal high tension tank |
| X ACT S/ | X-ray active signal |


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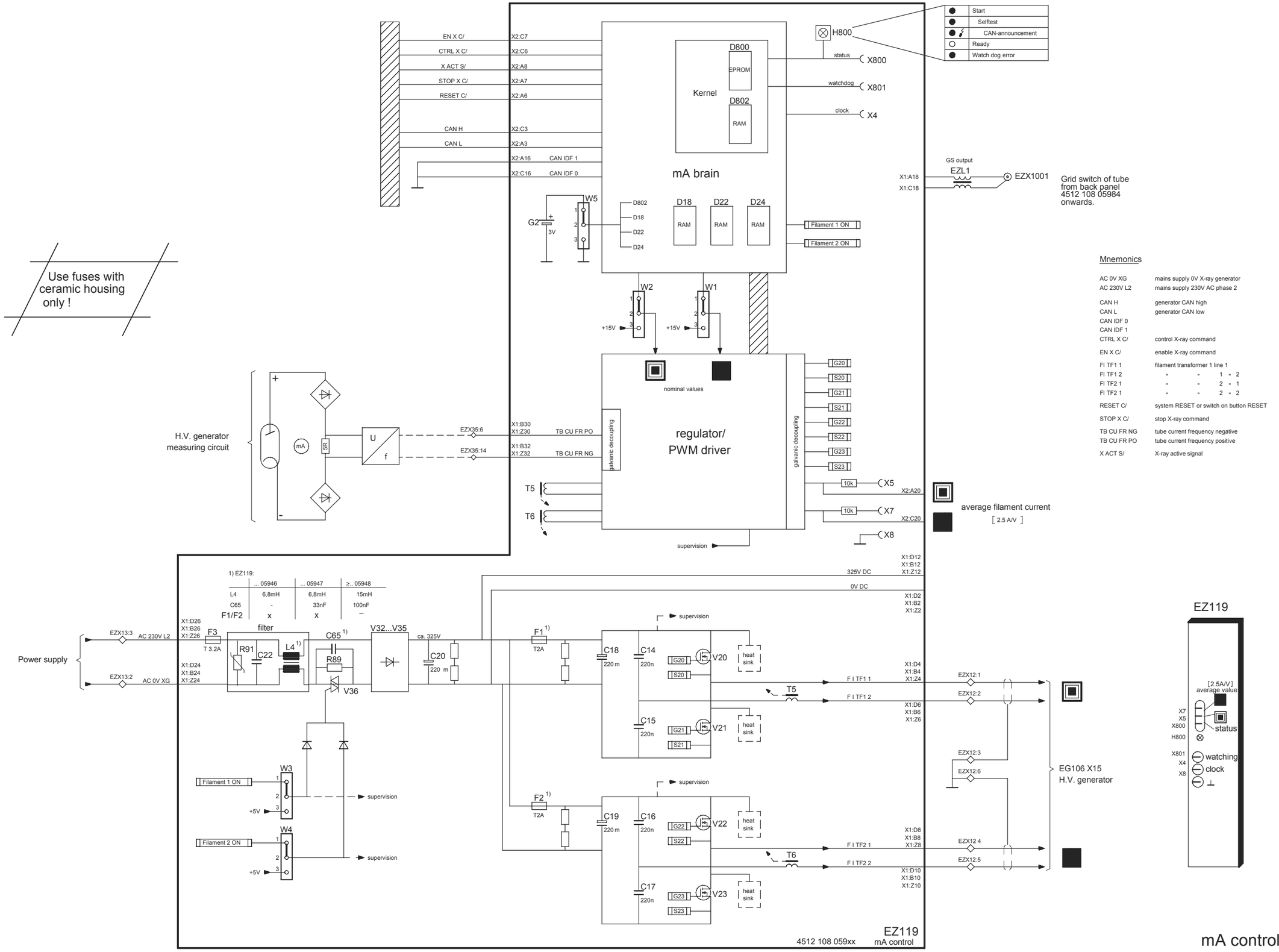


A1/A3 99-02-10 Schr.

# mA control

OPTIMUS R/F (99.0)

Z1-4.1

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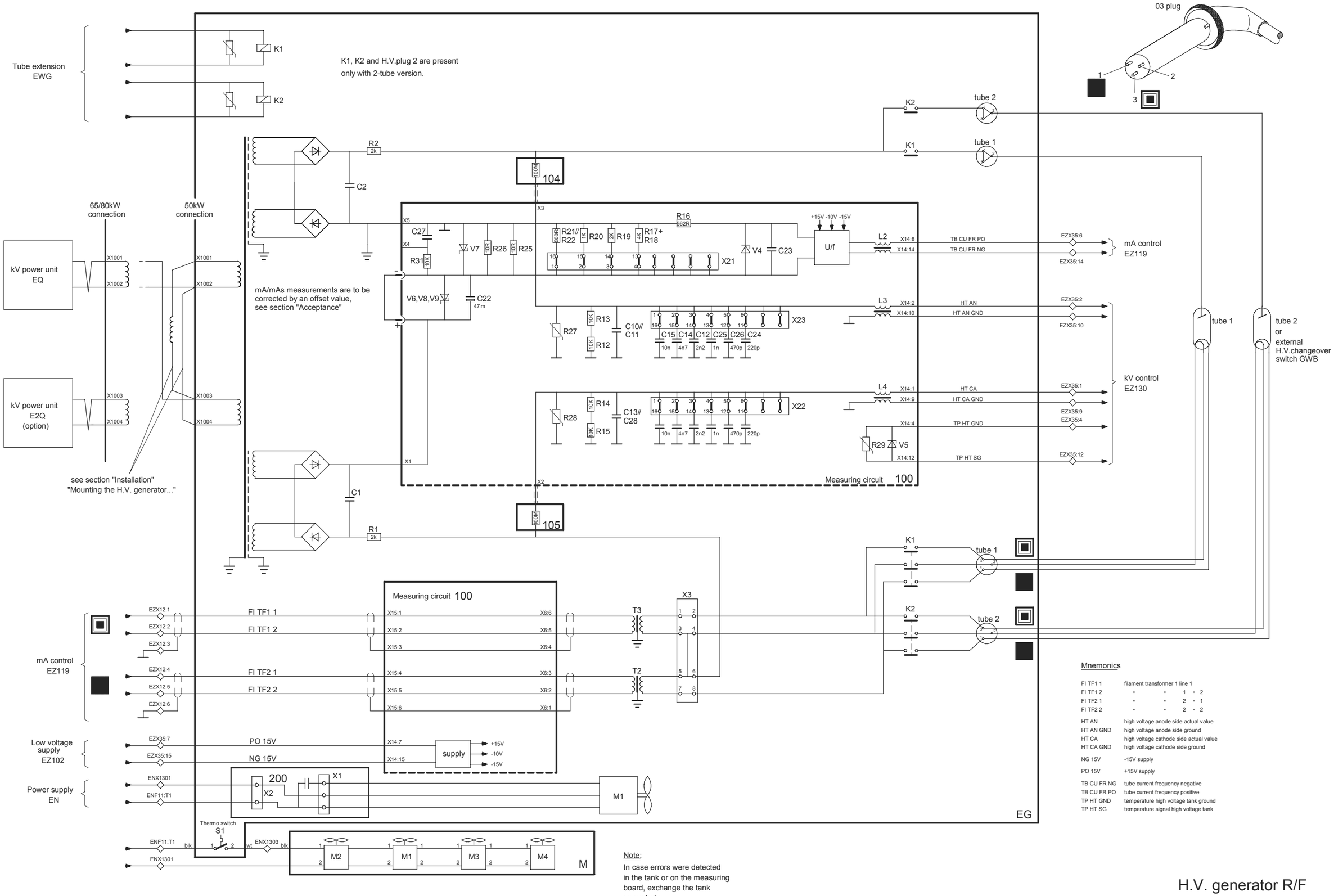


Mnemonics

| | |
|---|---|
| FI TF1 1 | filament transformer 1 line 1 |
| FI TF1 2 | " " 1 " 2 |
| FI TF2 1 | " " 2 " 1 |
| FI TF2 2 | " " 2 " 2 |
| HT AN | high voltage anode side actual value |
| HT AN GND | high voltage anode side ground |
| HT CA | high voltage cathode side actual value |
| HT CA GND | high voltage cathode side ground |
| NG 15V | -15V supply |
| PO 15V | +15V supply |
| TB CU FR NG | tube current frequency negative |
| TB CU FR PO | tube current frequency positive |
| TP HT GND | temperature high voltage tank ground |
| TP HT SG | temperature signal high voltage tank |

Note:
In case errors were detected in the tank or on the measuring board, exchange the tank as a whole.

A1/A3 99-06-08 Schr.

# H.V. generator R/F


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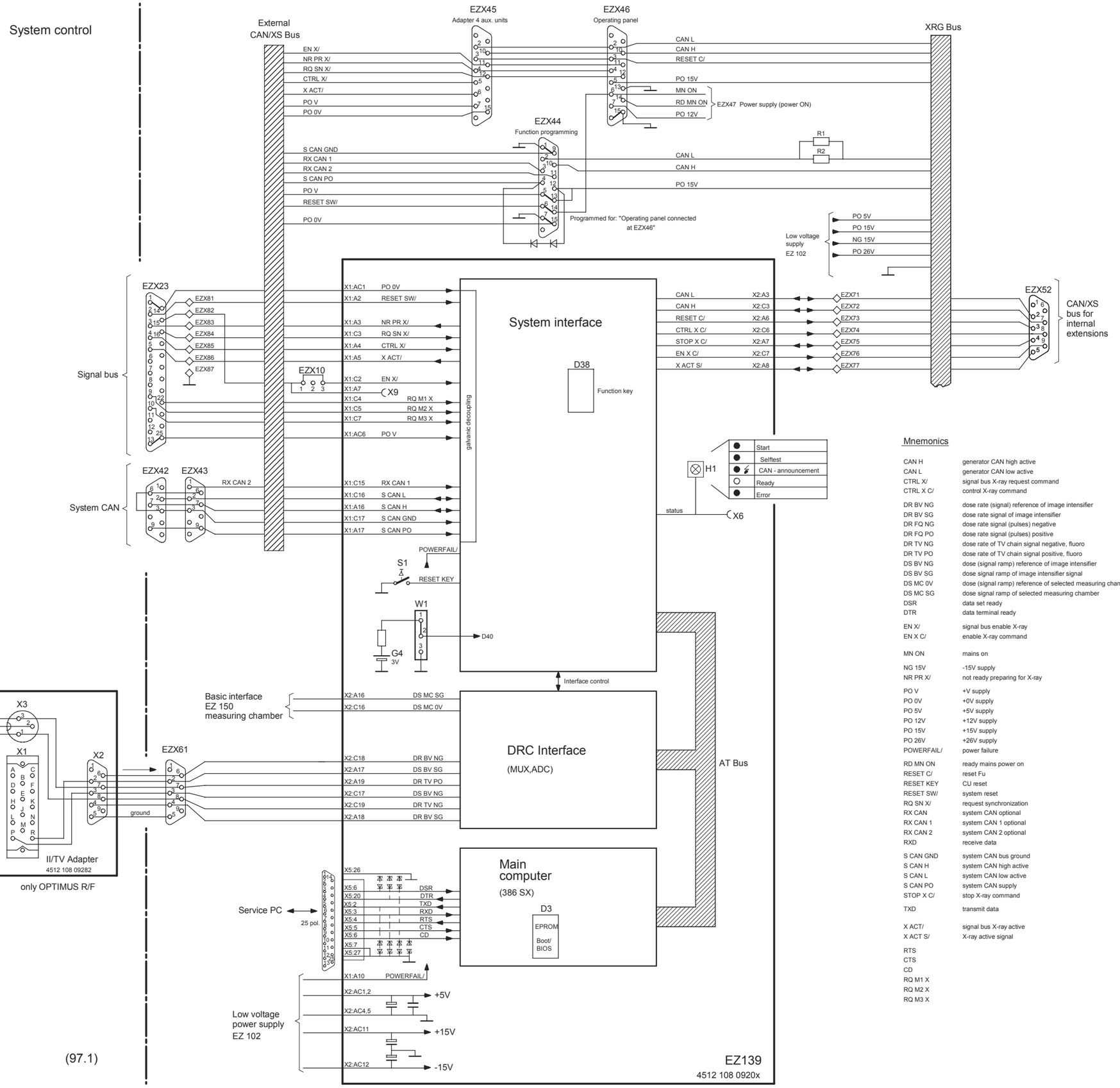
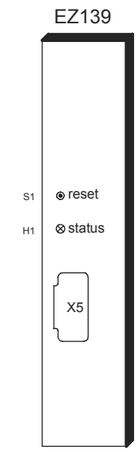



## Mnemonics

| | |
|---|---|
| CAN H | generator CAN high active |
| CAN L | generator CAN low active |
| CTRL X/ | signal bus X-ray request command |
| CTRL X C/ | control X-ray command |
| DR BV NG | dose rate (signal) reference of image intensifier |
| DR BV SG | dose rate signal of image intensifier |
| DR FQ NG | dose rate signal (pulses) negative |
| DR FQ PO | dose rate signal (pulses) positive |
| DR TV NG | dose rate of TV chain signal negative, fluoro |
| DR TV PO | dose rate of TV chain signal positive, fluoro |
| DS BV NG | dose (signal ramp) reference of image intensifier |
| DS BV SG | dose signal ramp of image intensifier signal |
| DS MC 0V | dose (signal ramp) reference of selected measuring chamber |
| DS MC SG | dose signal ramp of selected measuring chamber |
| DSR | data set ready |
| DTR | data terminal ready |
| EN X/ | signal bus enable X-ray |
| EN X C/ | enable X-ray command |
| MN ON | mains on |
| NG 15V | -15V supply |
| NR PR X/ | not ready preparing for X-ray |
| PO V | +V supply |
| PO 0V | +0V supply |
| PO 5V | +5V supply |
| PO 12V | +12V supply |
| PO 15V | +15V supply |
| PO 26V | +26V supply |
| POWERFAIL/ | power failure |
| RD MN ON | ready mains power on |
| RESET C/ | reset Fu |
| RESET KEY | CU reset |
| RESET SW/ | system reset |
| RQ SN X/ | request synchronization |
| RX CAN | system CAN optional |
| RX CAN 1 | system CAN 1 optional |
| RX CAN 2 | system CAN 2 optional |
| RXD | receive data |
| S CAN GND | system CAN bus ground |
| S CAN H | system CAN high active |
| S CAN L | system CAN low active |
| S CAN PO | system CAN supply |
| STOP X C/ | stop X-ray command |
| TXD | transmit data |
| X ACT/ | signal bus X-ray active |
| X ACT S/ | X-ray active signal |
| RTS | |
| CTS | |
| CD | |
| RQ M1 X | |
| RQ M2 X | |
| RQ M3 X | |




A1/A3 99-02-10 Schr.

OPTIMUS R/F (97.1)

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Central unit

Z1-5.1

4512 983 05531
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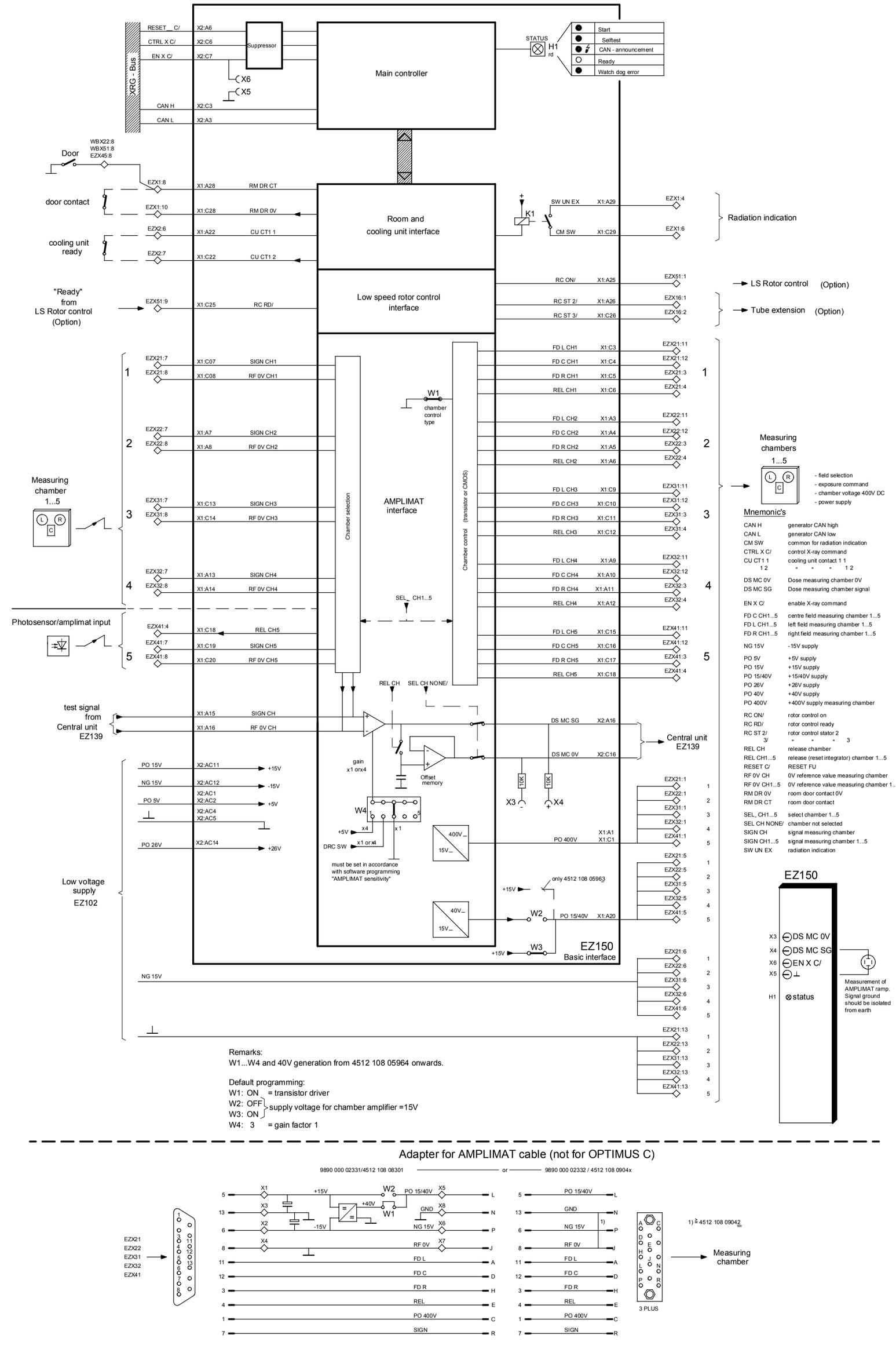
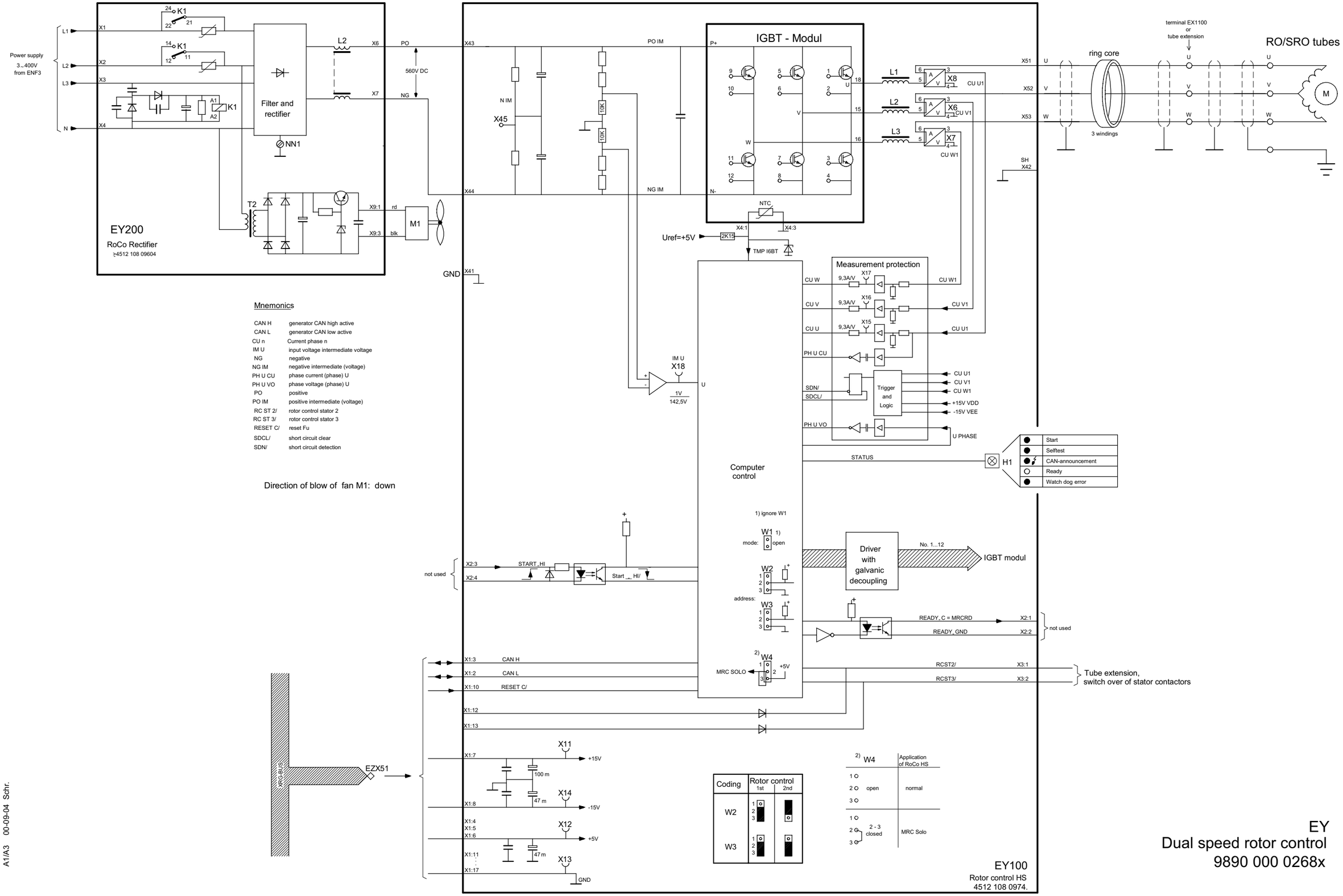
(02.0)




## Adapter for AMPLIMAT cable (not for OPTIMUS C)




## Mnemonics

| | |
|---|---|
| CAN H | generator CAN high active |
| CAN L | generator CAN low active |
| CU n | Current phase n |
| IM U | input voltage intermediate voltage |
| NG | negative |
| NG IM | negative intermediate (voltage) |
| PH U CU | phase current (phase) U |
| PH U VO | phase voltage (phase) U |
| PO | positive |
| PO IM | positive intermediate (voltage) |
| RC ST 2/ | rotor control stator 2 |
| RC ST 3/ | rotor control stator 3 |
| RESET C/ | reset Fu |
| SDCL/ | short circuit clear |
| SDN/ | short circuit detection |

Direction of blow of fan M1: down

A1/A3 00-09-04 Schr.

# EY
# Dual speed rotor control
# 9890 000 0268x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# Wiring diagrams

Cabinet E with duo DIAGNOST . . . . . Z2-1.0
Cabinet wiring E, 50 kW . . . . . Z2-1.1
Cabinet wiring E, 65/80 kW . . . . . Z2-1.2
Earthing diagram E . . . . . Z2-1.3

Power supply N, 50 kW . . . . . Z2-2.1.1/.2
Power supply N, 65/80 kW . . . . . Z2-2.2.1/.2

Backpanel EZ / Basis rack-2 Z 4512 108 0936 . . . . . Z2-5.1/.2/.3
Backpanel EZ / Basis rack-2 Z survey of components . . . . . Z2-5.4

Dual speed rotor control
9890 000 0268x . . . . . Z2-13

Cabinet wiring: Tube extension WG and air coolers H.V. generator . . . . . Z2-14.1
Air coolers H.V. generator . . . . . Z2-14.4

Cabinet wiring: Control desk C . . . . . Z2-17


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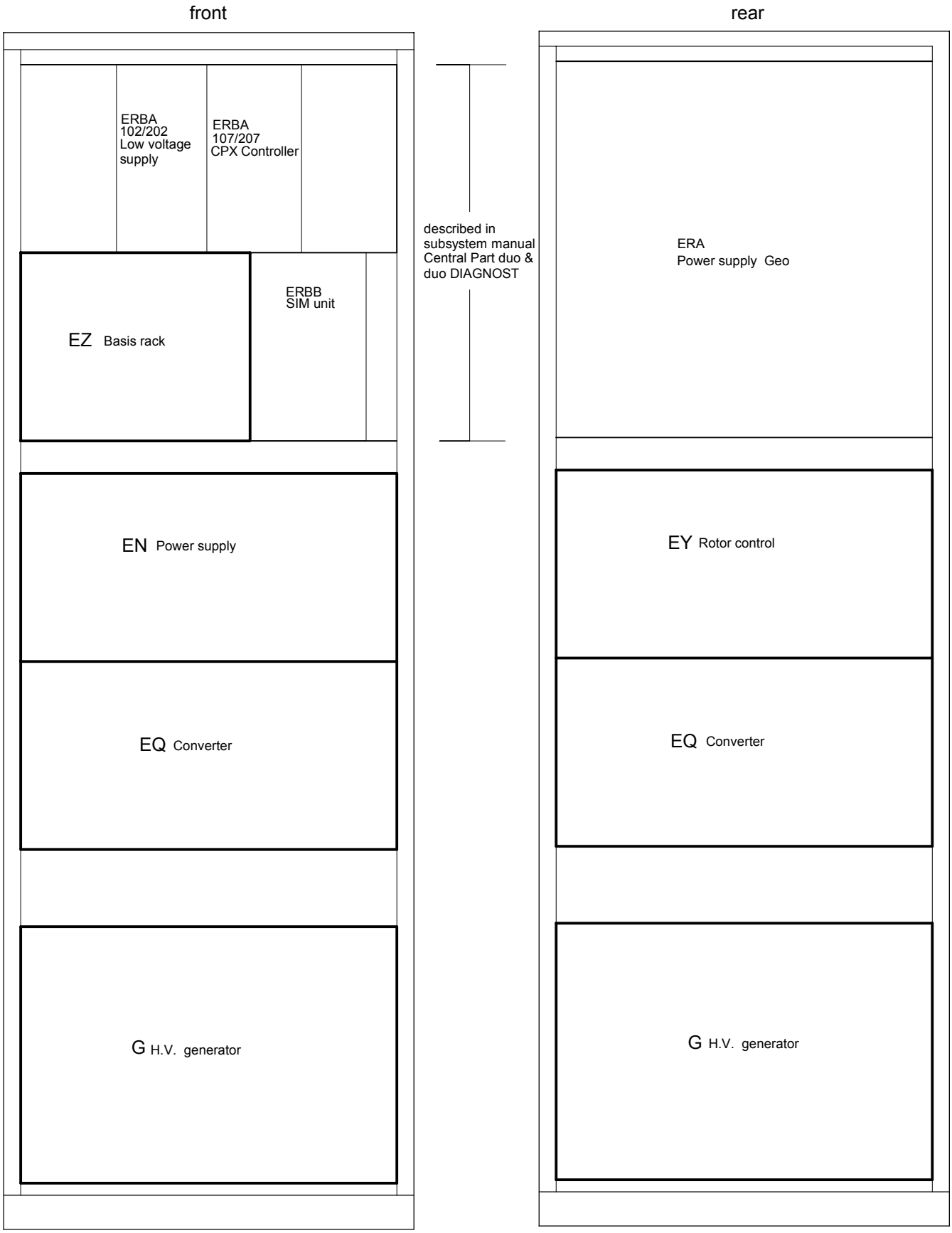


A3/A4 00-11-14 Schr.

E-Cabinet
with duo DIAGNOST


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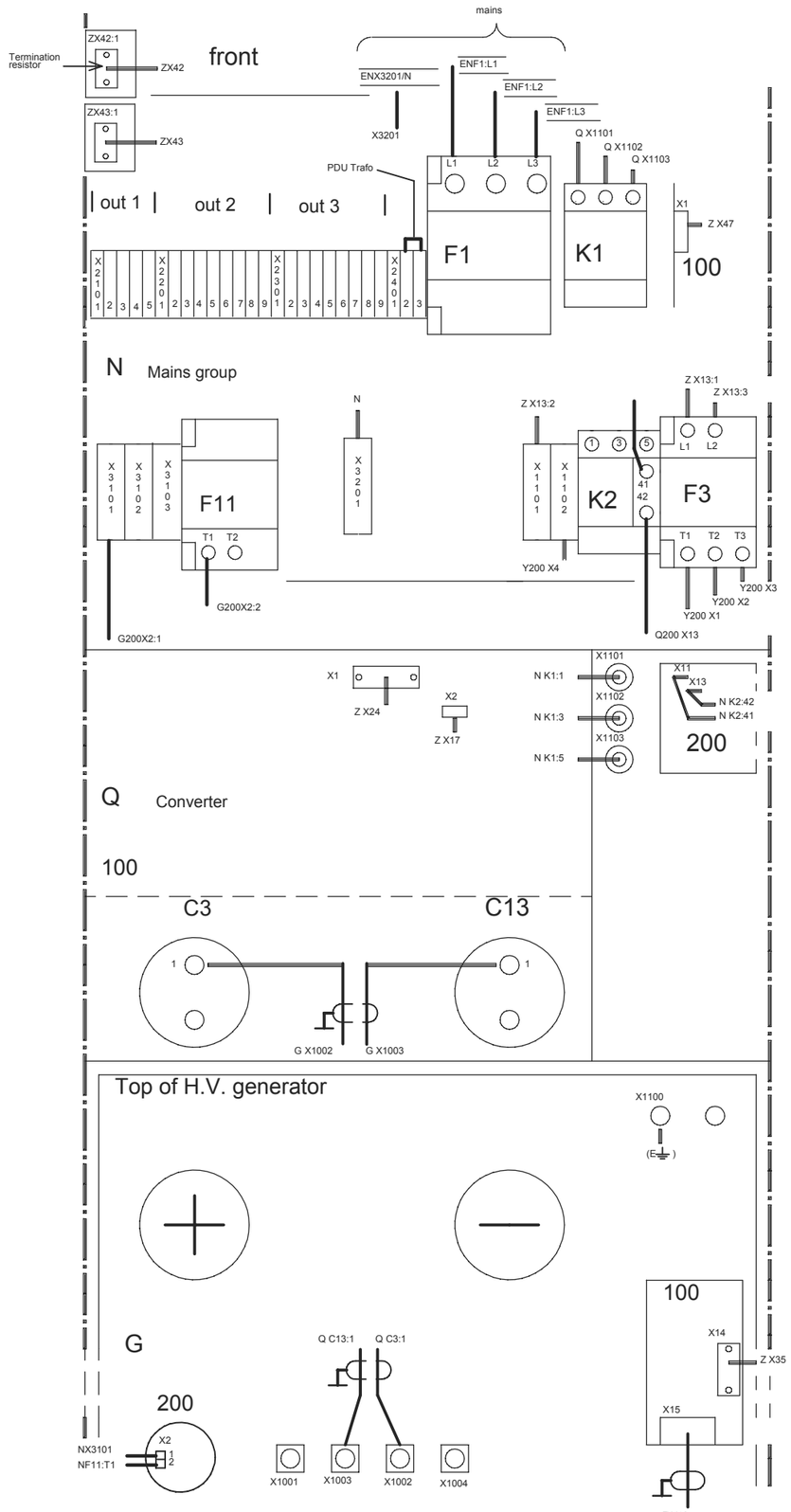


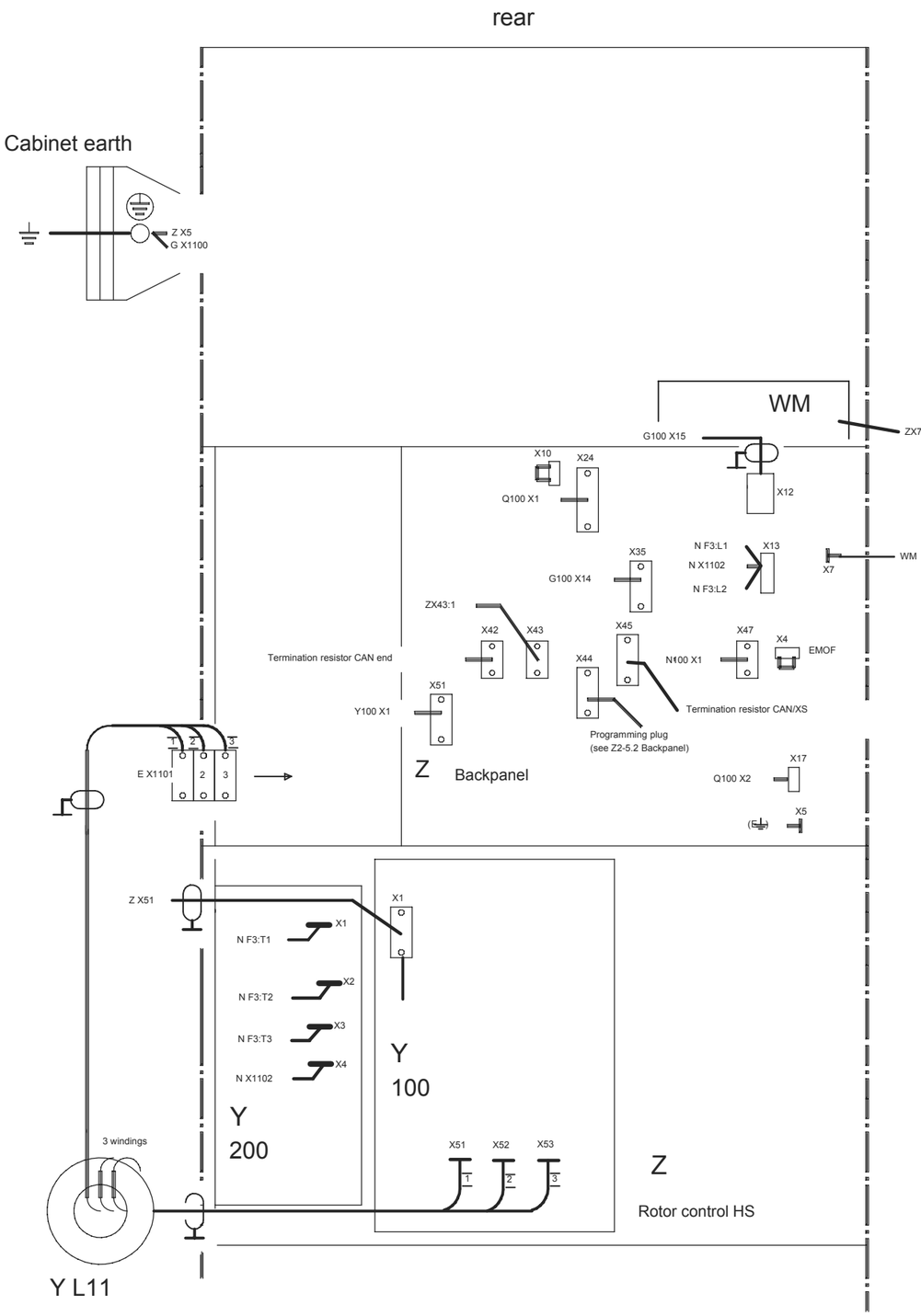




E
Cabinet wiring
50kW R/F

Z2-1.1


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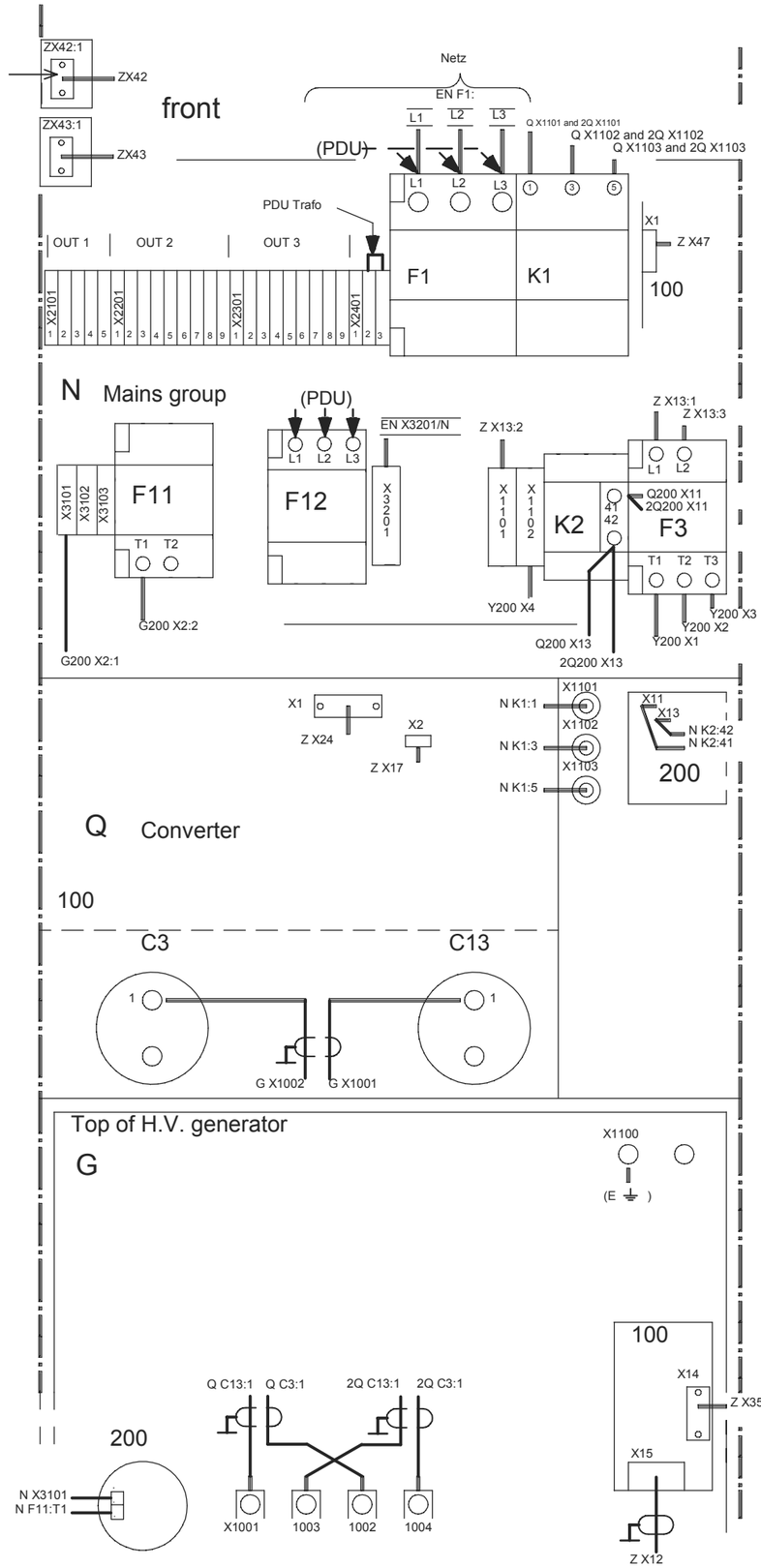


A3/A3 99-07-27 Schr./Ost.

E
Cabinet wiring
65/80 kW R/F

Z2-1.2


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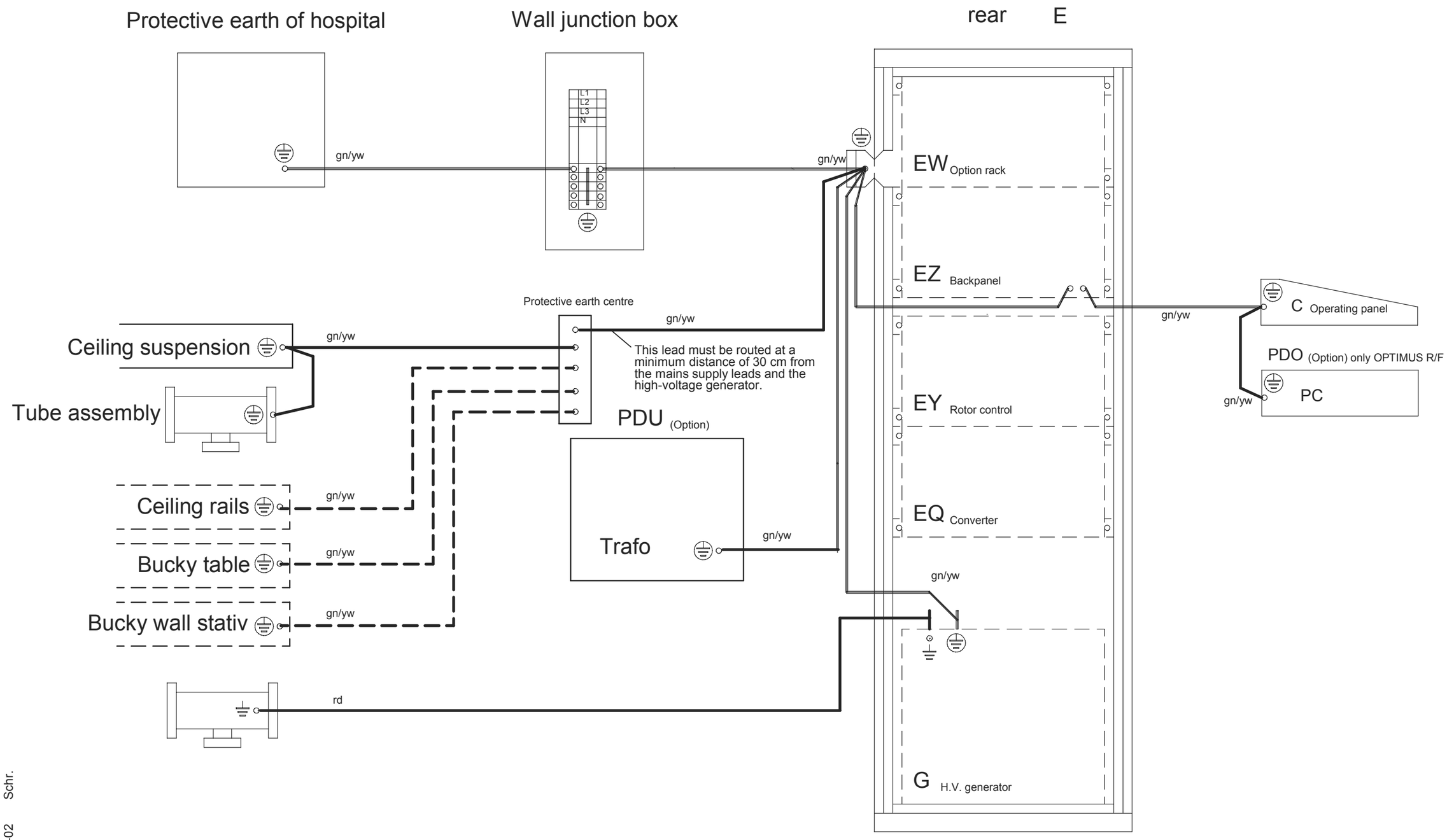


A3/A3 98-07-02 Schr.

E
Earthing diagram


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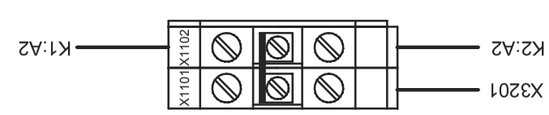
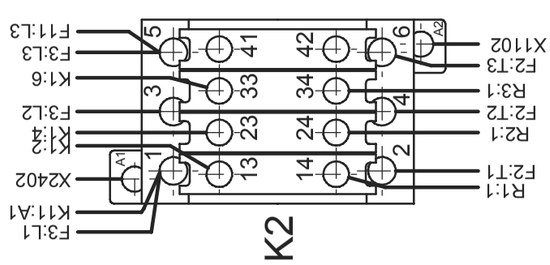
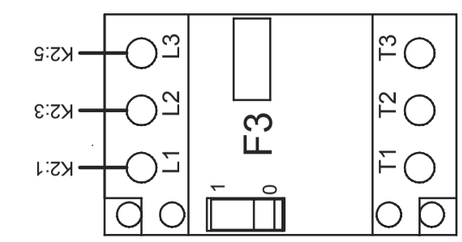
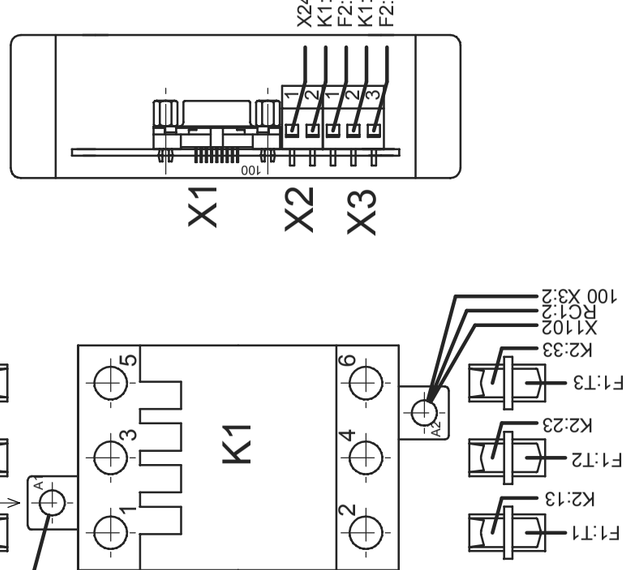
N
Power supply
50kW R/F

Z2-2.1.1



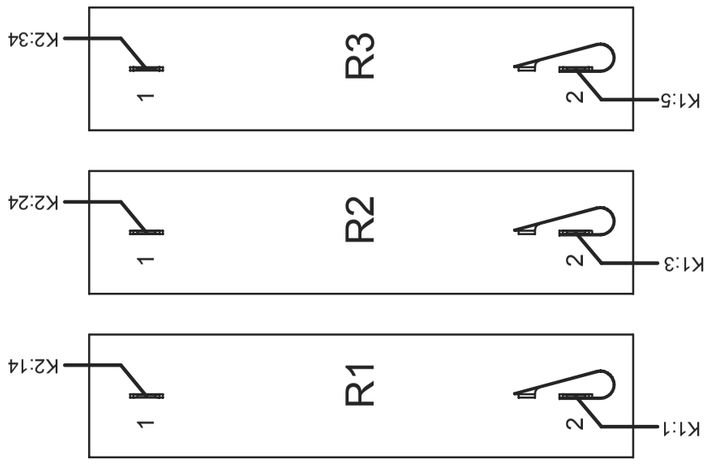



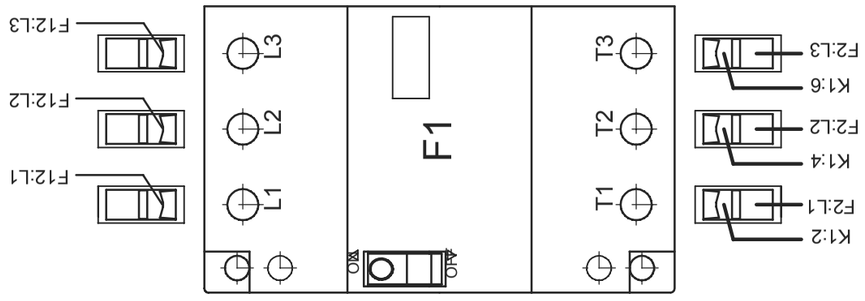





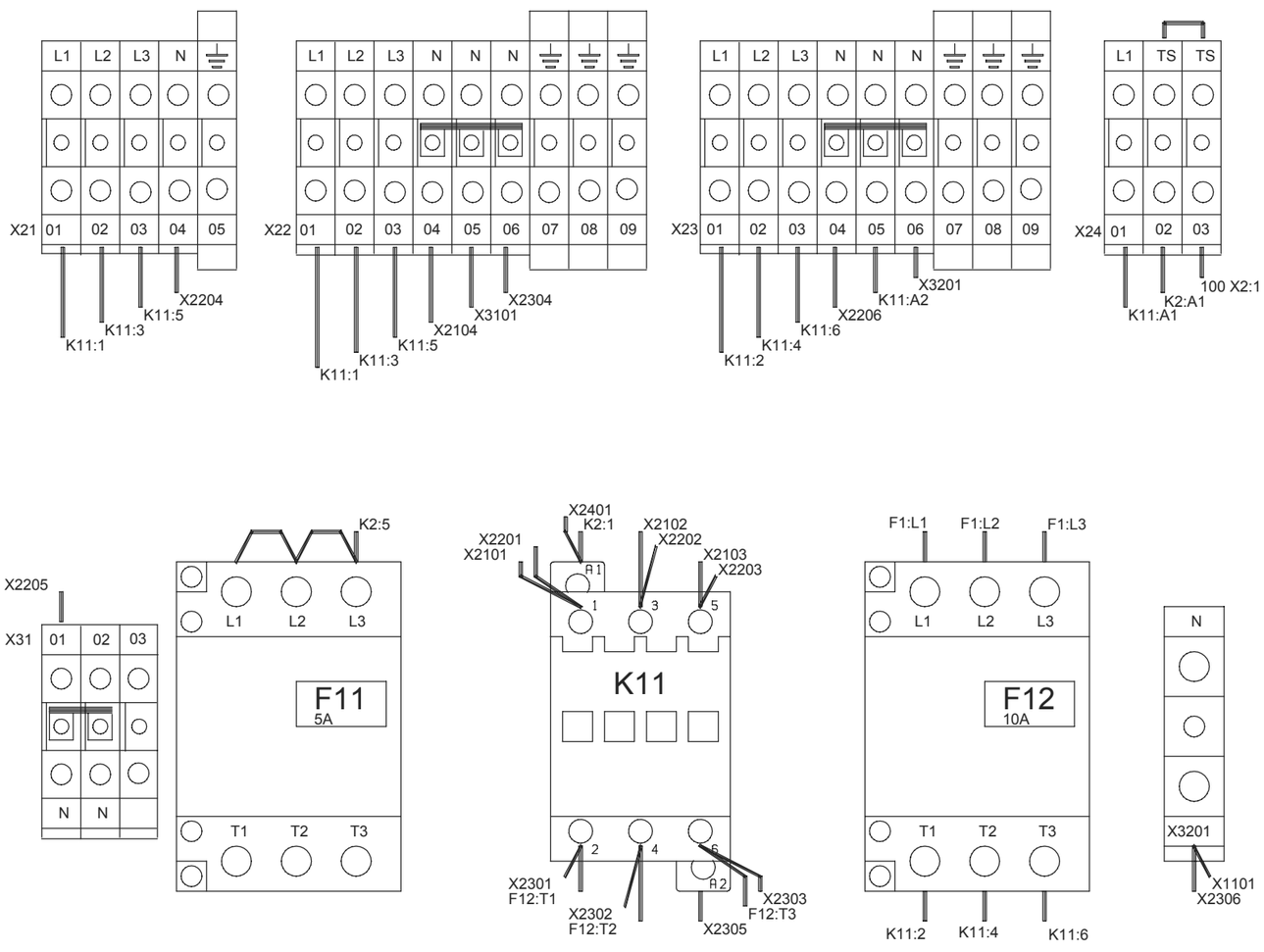





A3/A3 99-02-10 Schr.

OPTIMUS R/F
© Philips Medical Systems (97.0)

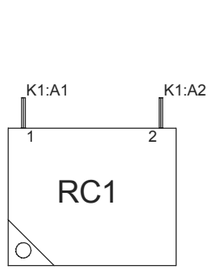


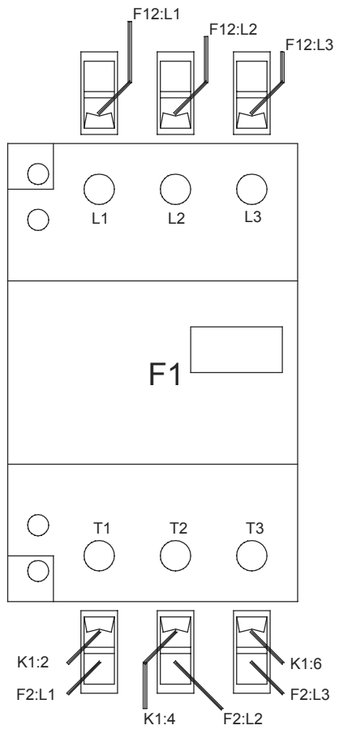

A3/A3 99-02-10 Schr.

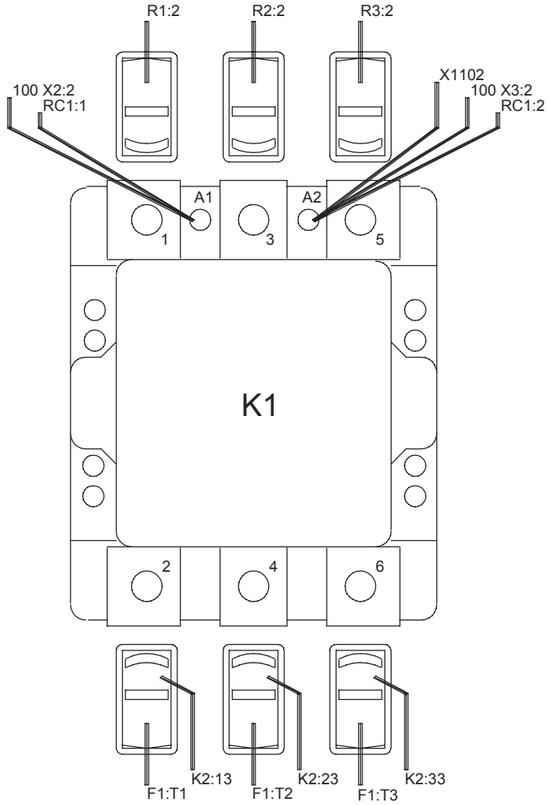
N
Power supply
50 kW R/F

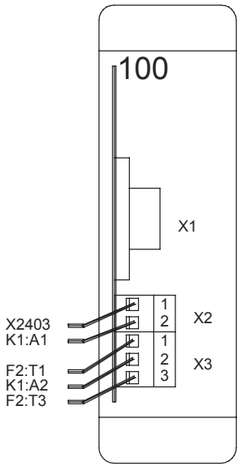
Z2-2.1.2

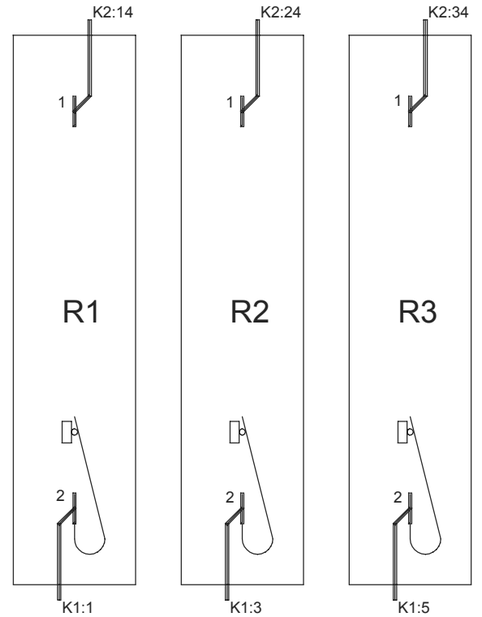

© Philips Medical Systems

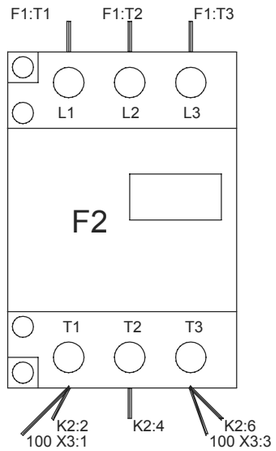


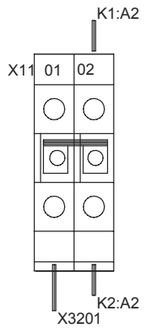



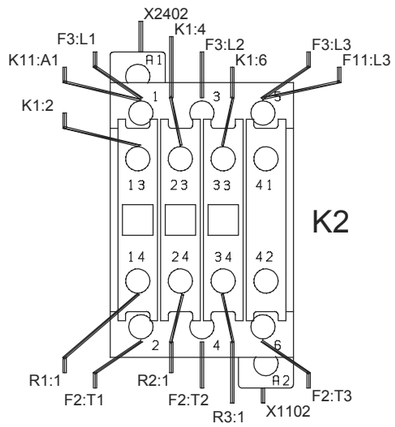



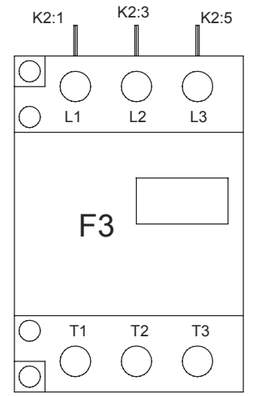




A3/A3 99-02-10 Schr.

N
Power supply
65/80 kW R/F

Z2-2.2.1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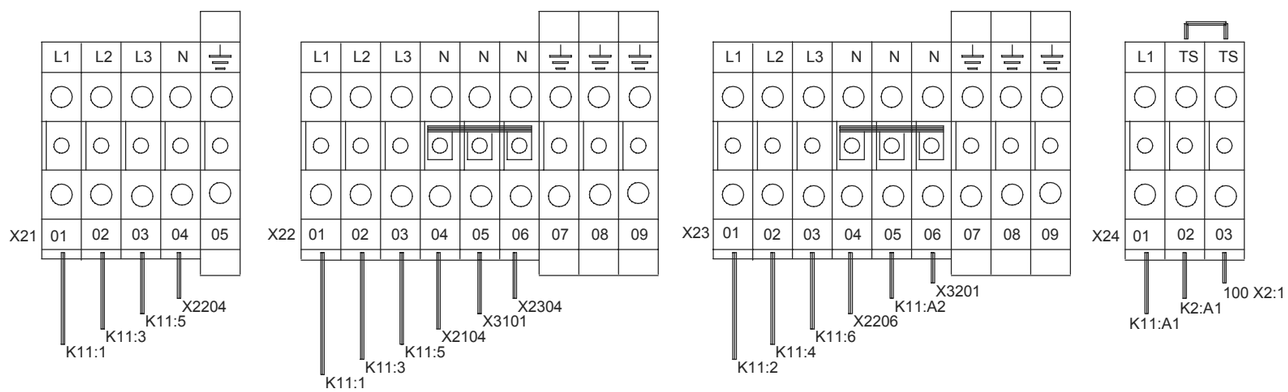
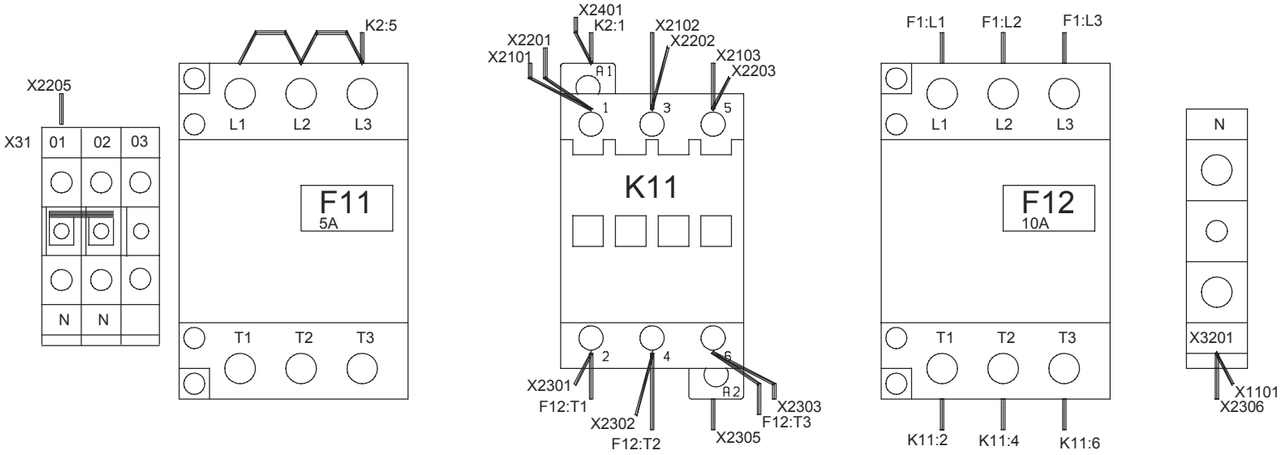


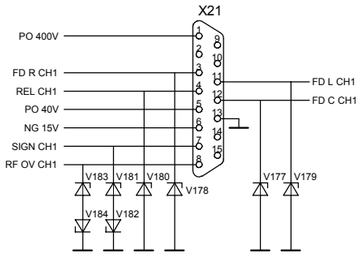




A3/A3 99-02-10 Schr.

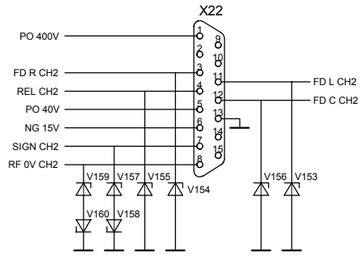
N
Power supply
65/80 kW R/F


© Philips Medical Systems

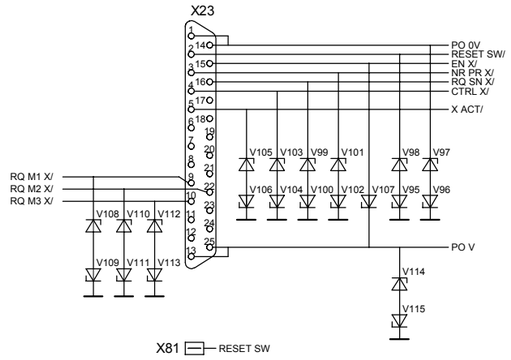
Measuring chamber 1



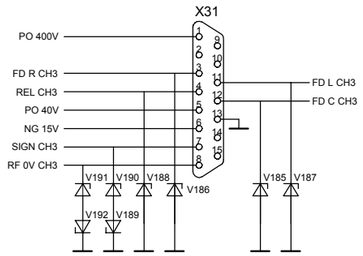

Measuring chamber 2



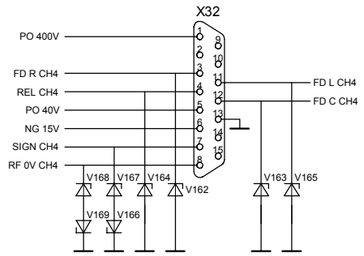

Signal bus




Measuring chamber 3

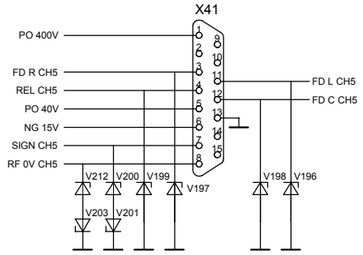



Measuring chamber 4

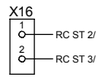



X81 RESET SW
X82 EN X/
X83 NR PR X/
X84 RQ SN X/
X85 CTRL X/
X86 X ACT/
X87

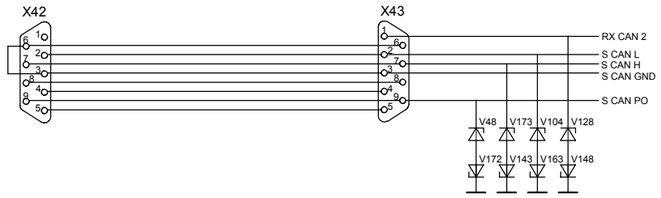
Measuring chamber 5



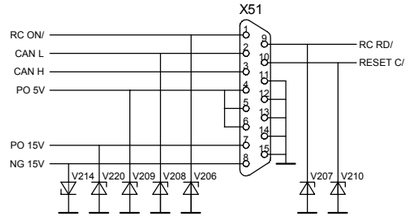

Tube extension



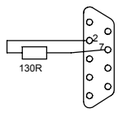

System CAN



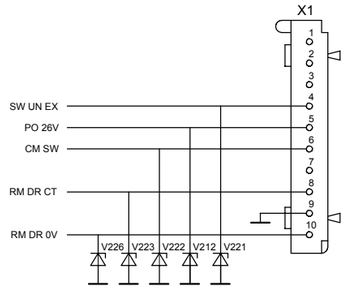

Rotor control 1



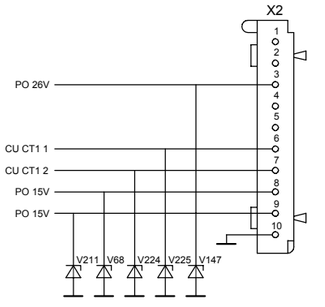

Termination resistor for X42 or X43



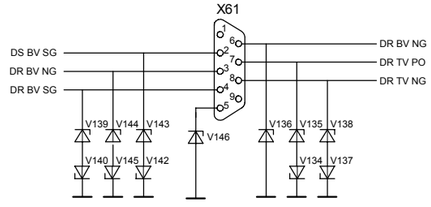

Room decade




Cooling unit control




DRC input




For survey of the components see Z2-5.4

A1/A3 02-02-14 Schr.

Backpanel
Basis rack-2 Z
4512 108 0936.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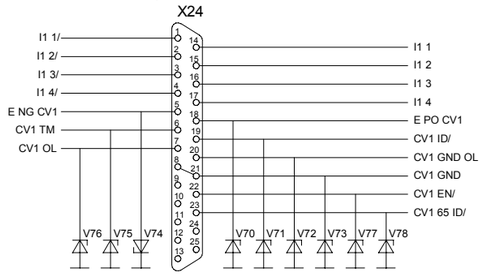
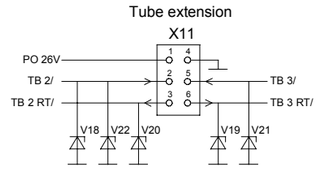
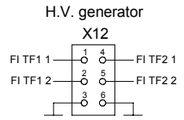
kV power unit EQ



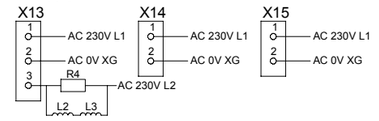

Tube extension



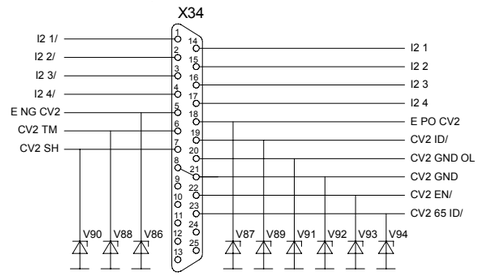

H.V. generator



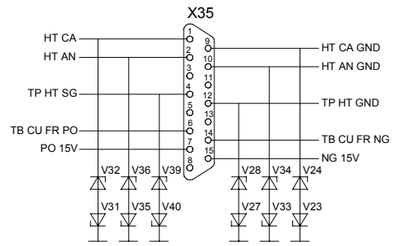

Power supply



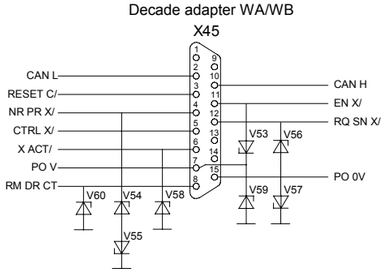

kV power unit E2Q



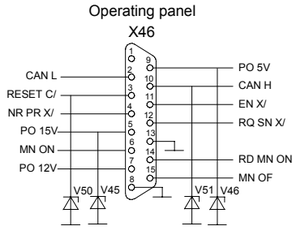

H.V. generator



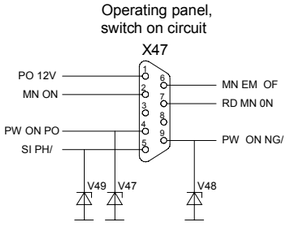

Decade adapter WA/WB



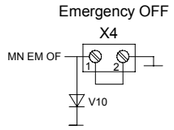

Operating panel



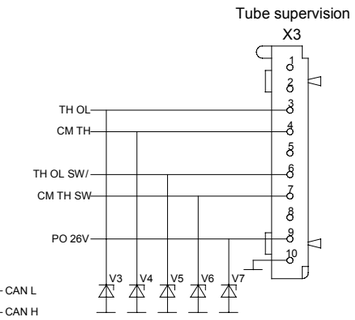

Operating panel, switch on circuit

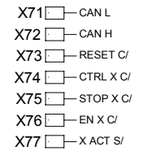



Emergency OFF

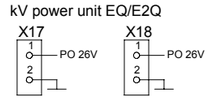



Tube supervision

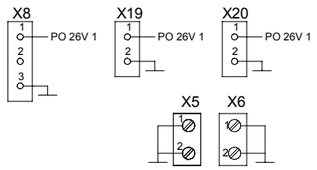


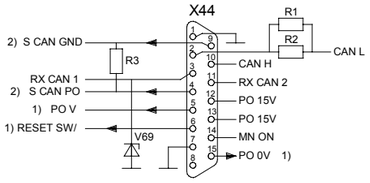

kV power unit EQ/E2Q



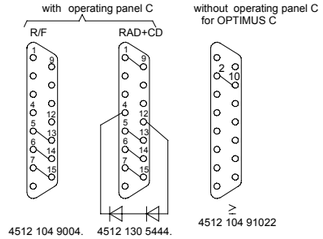

Operating panel




X44

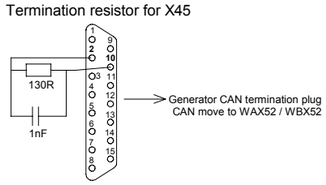



Function programming plug for X44

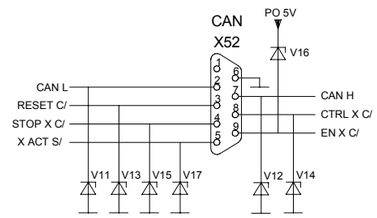



1) To Signal Bus X23
2) To System CAN X43

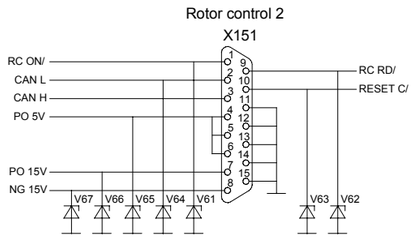
Termination resistor for X45




CAN X52




Rotor control 2




For survey of the components see Z2-5.4

A1/A3 02-03-19 Schr./Kö

Backpanel EZ
Basis rack-2 Z
4512 108 0936.



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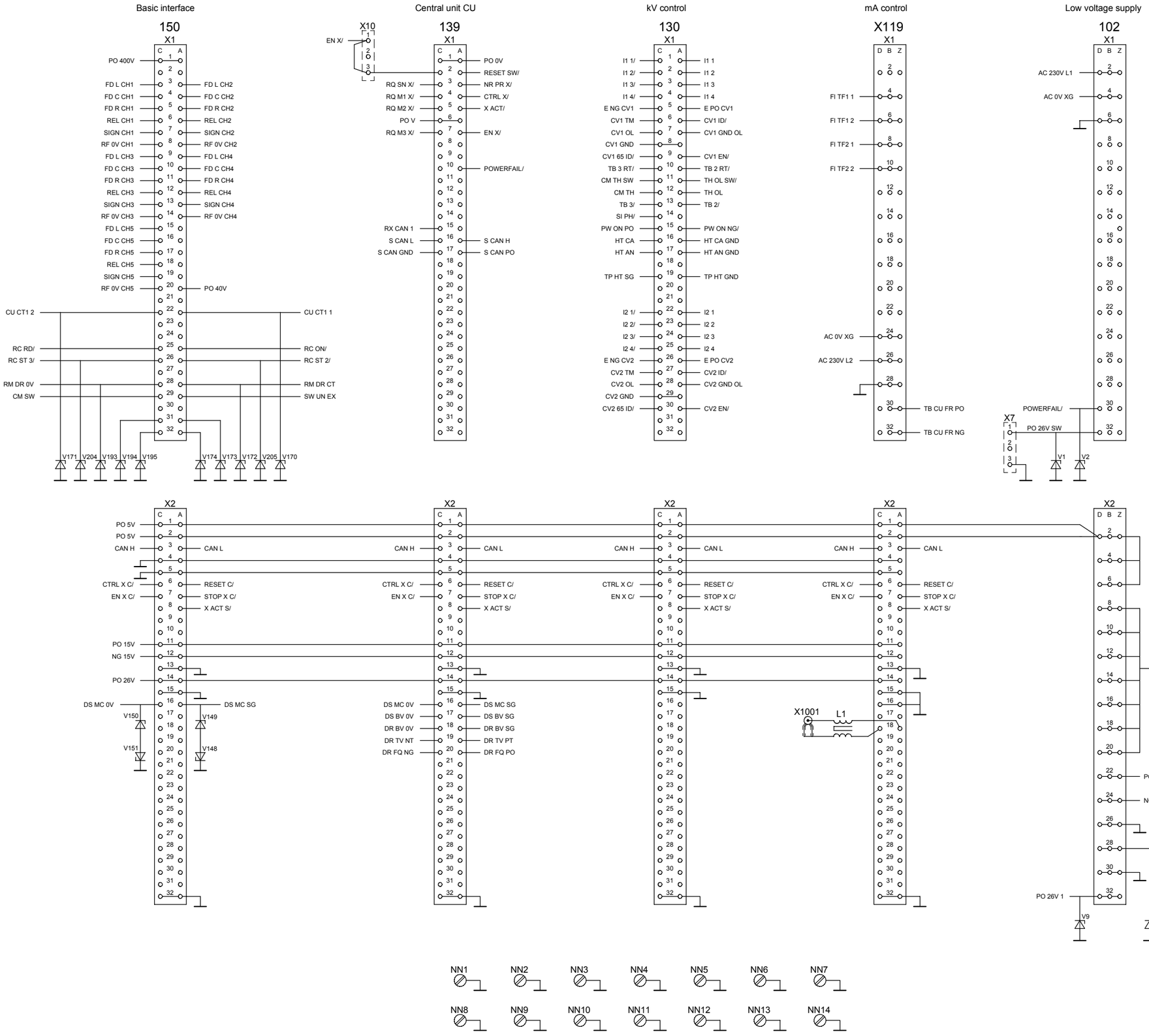


For survey of the components see Z2-5.4

A1/A3 02-02-14 Schr.

Backpanel EZ
Basis rack-2 Z
4512 108 0936.



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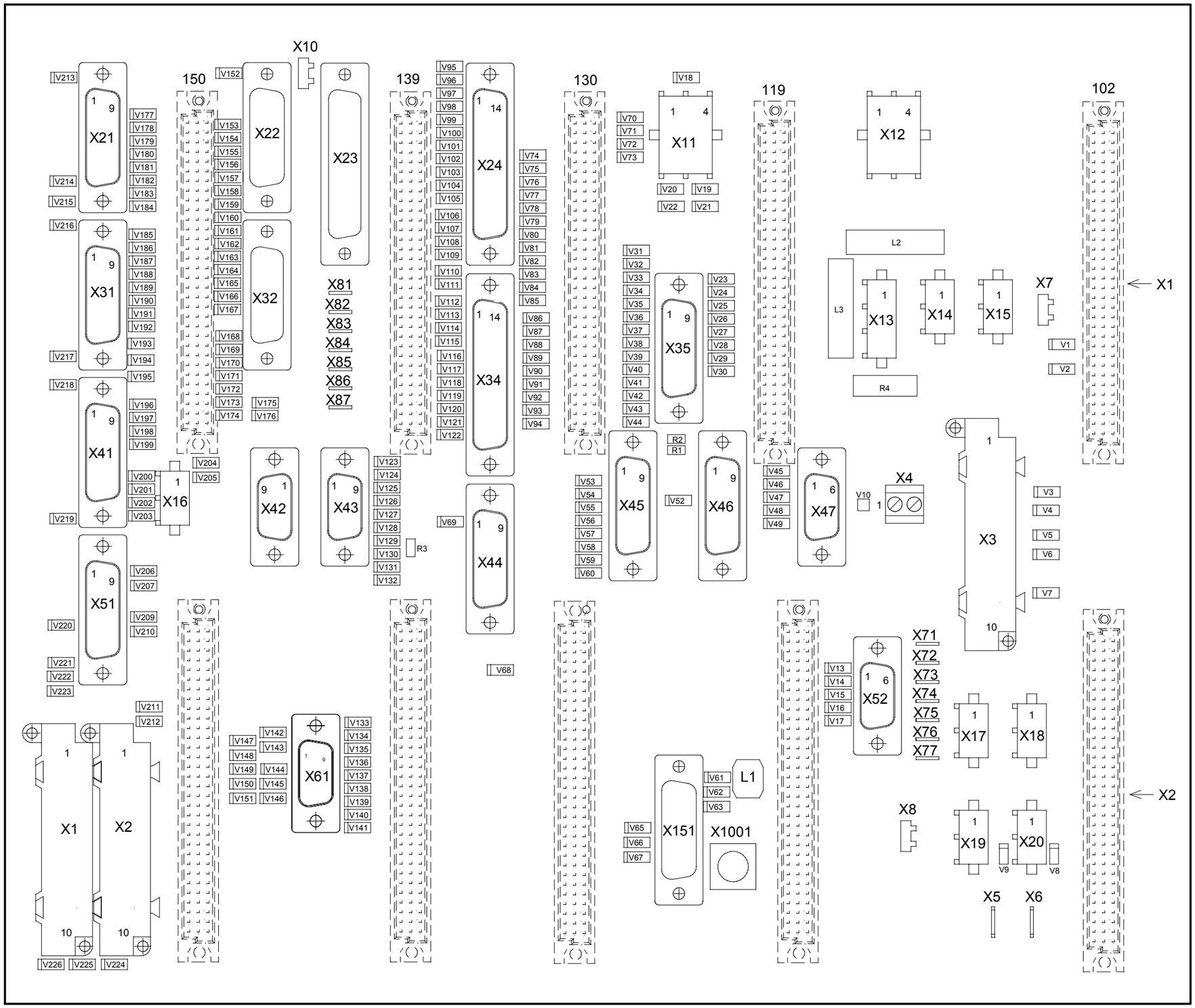
rear side




Backpanel EZ
Basis rack 2 Z
survey of components

A2/A3 02-02-14 Schr.



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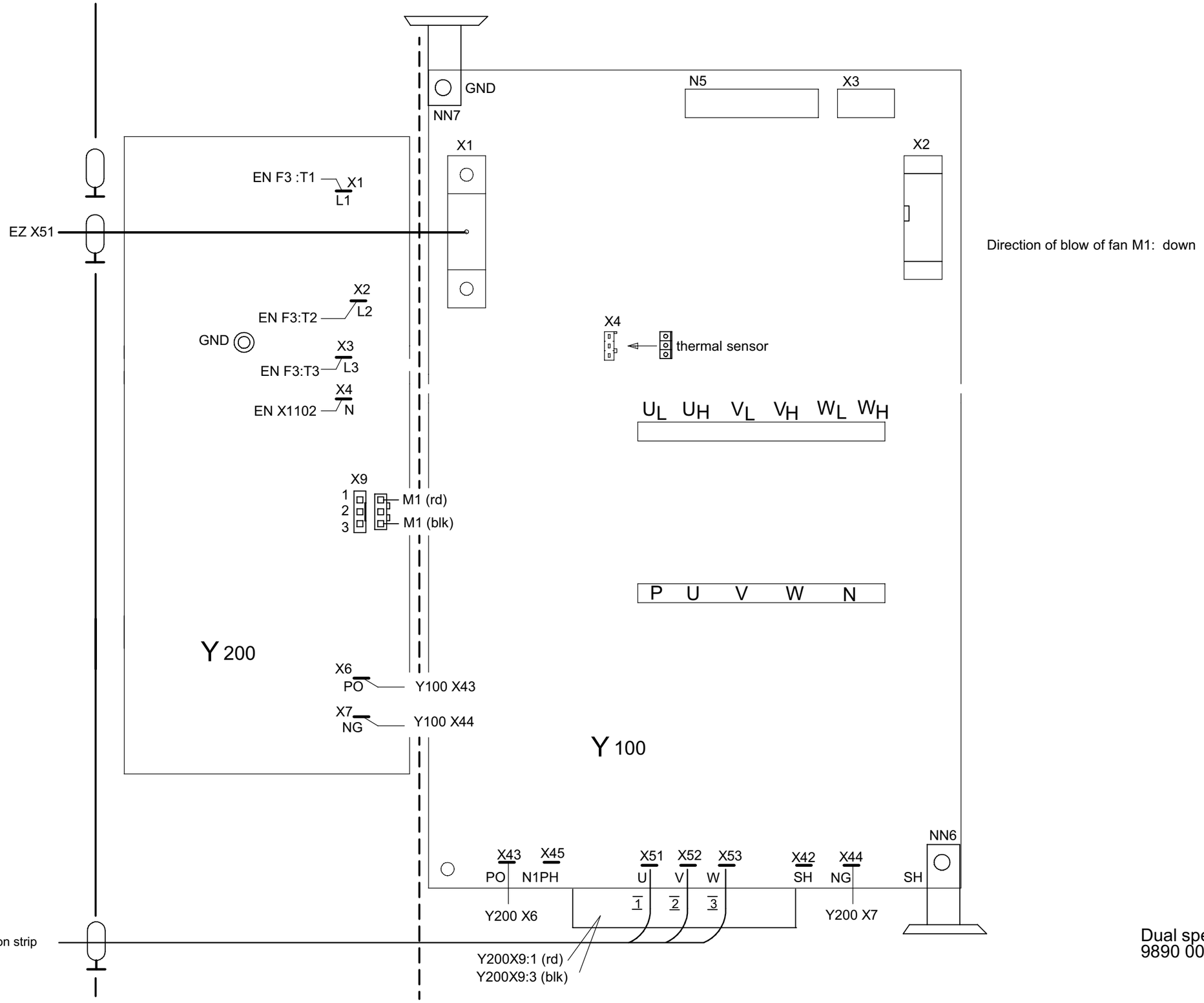


Direction of blow of fan M1: down

A3/A3 00-09-04 Schr.

Y
Dual speed rotor control
9890 000 0268x


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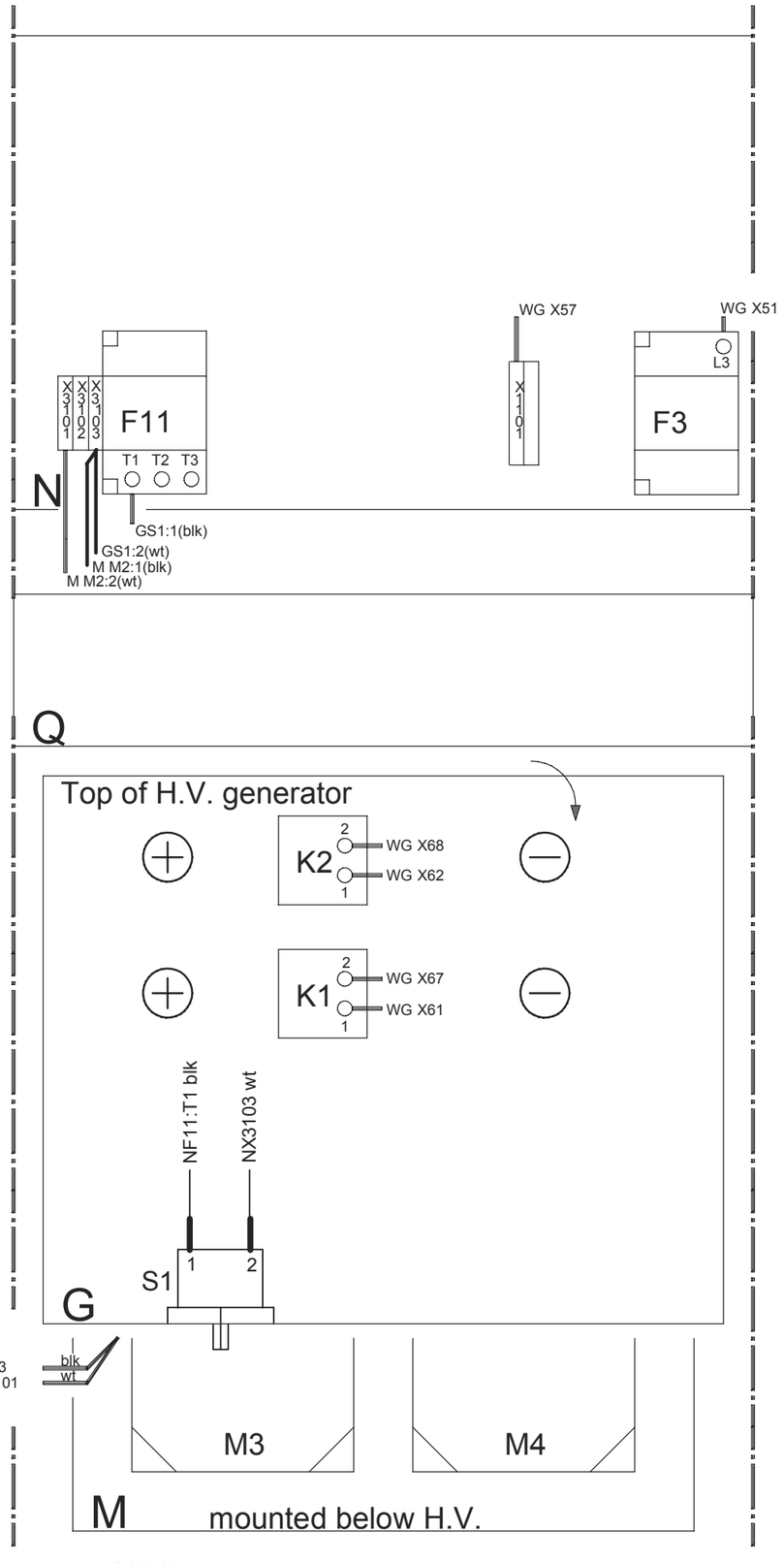


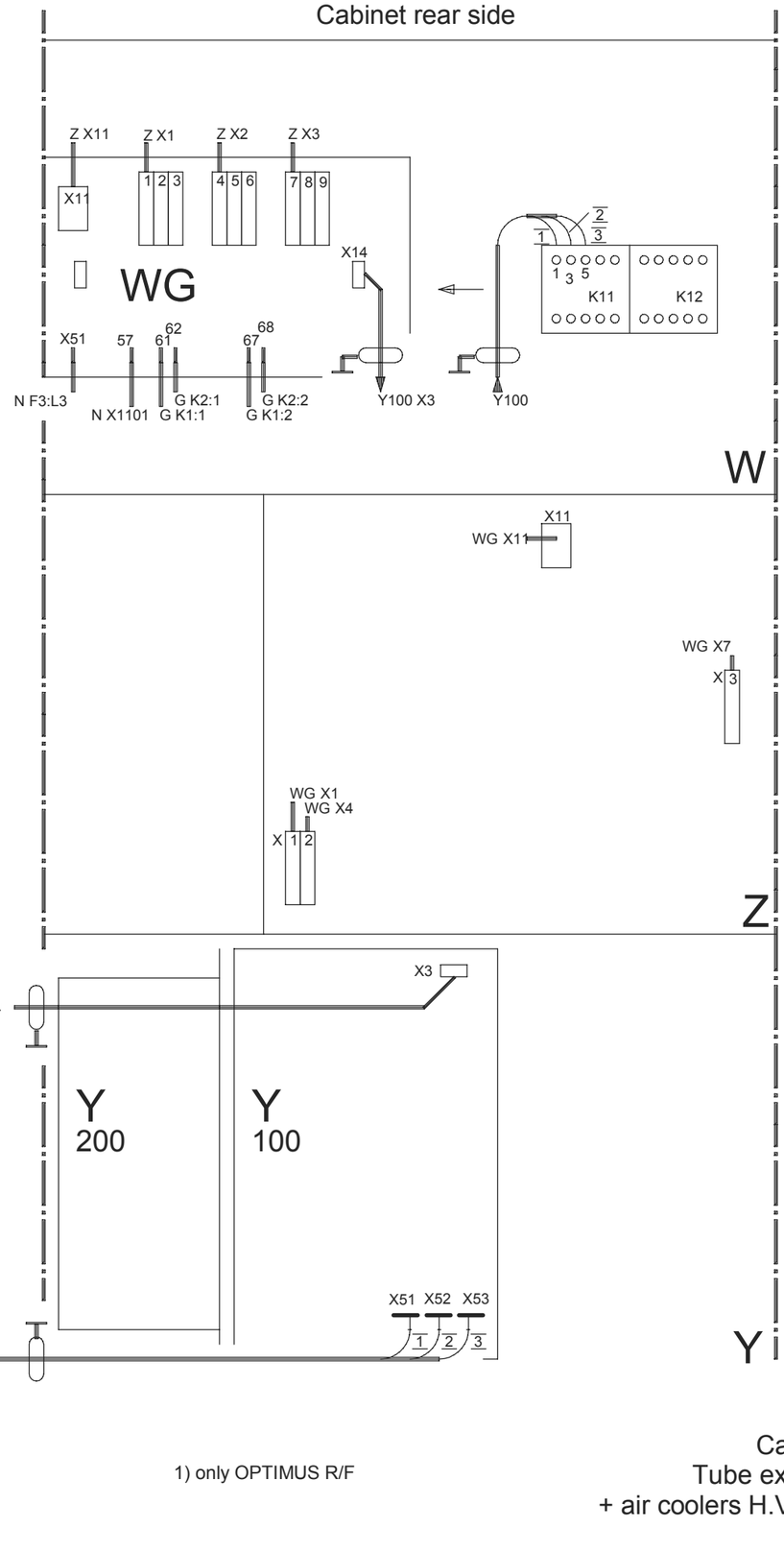


1) only OPTIMUS R/F

Cabinet wiring
Tube extension WG [1]
+ air coolers H.V. generator

A3/A3 99-03-19 Schr.

OPTIMUS R/F (b/99.0)

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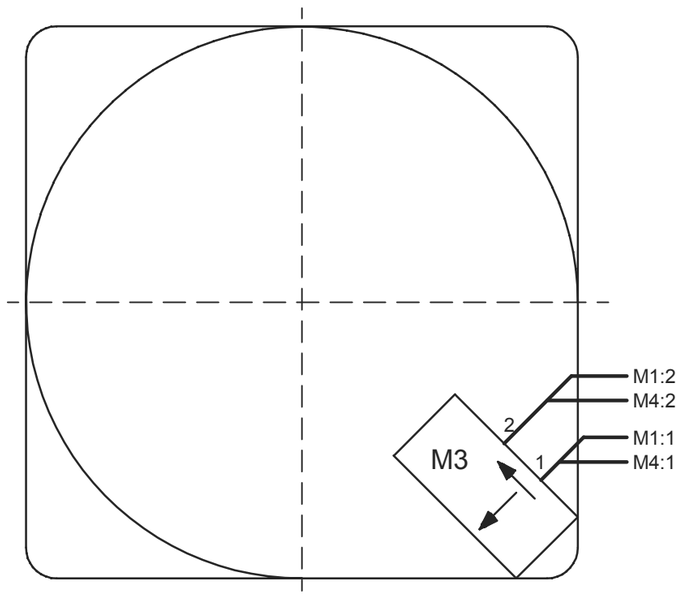
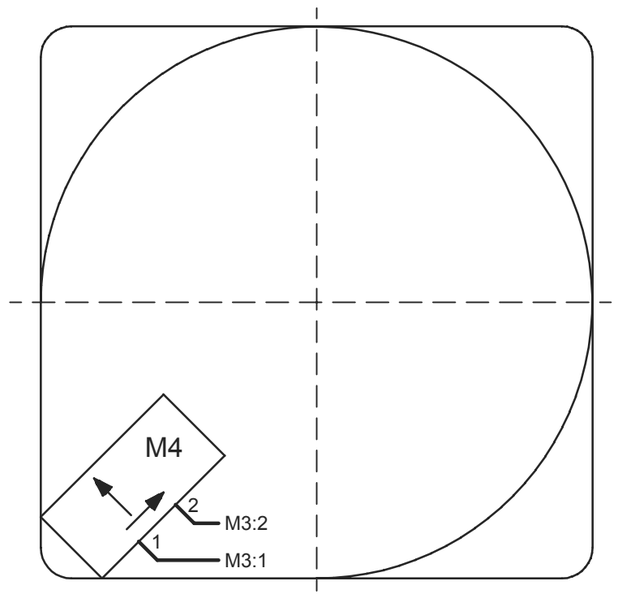
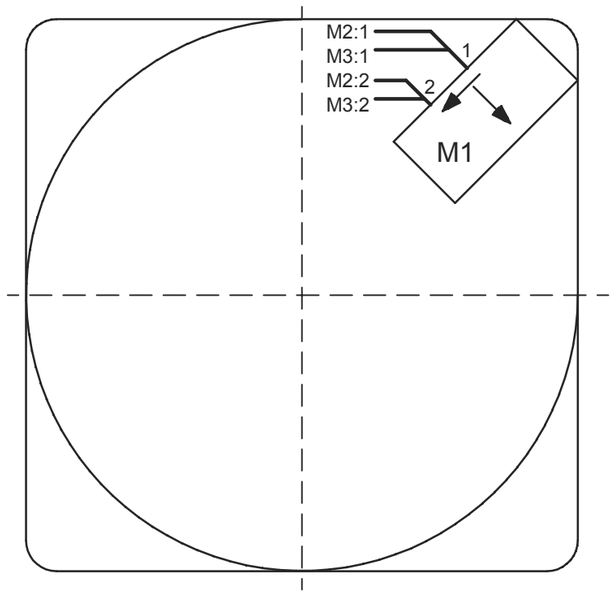
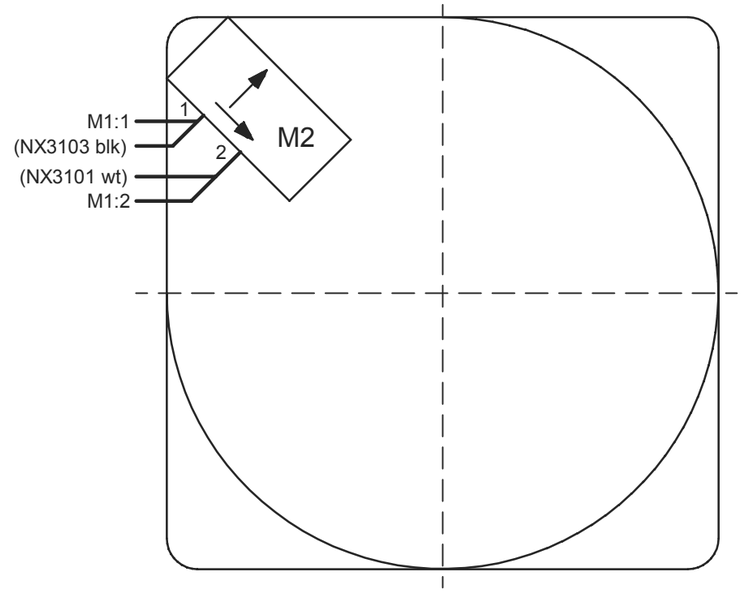
Z2-14.1

wiring side




A3/A3 97-07-07 Schr.

M
Air coolers H.V. generator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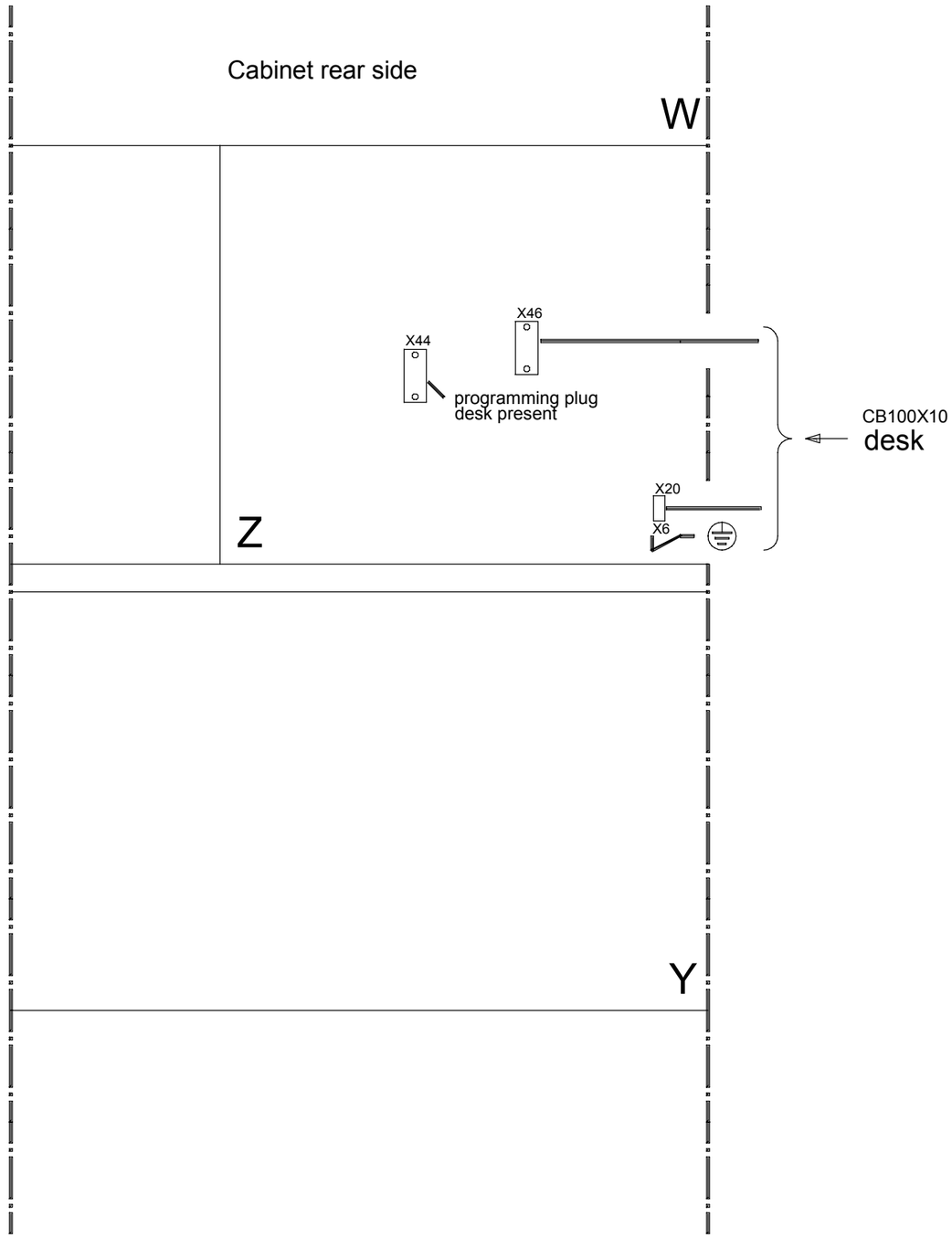


A3/A3 98-07-24 Schr.

CB
Cabinet wiring
Control desk


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